UNIVERSITY OF MICHIGAN
AUG 8 1956
PERIODICAL READING ROOM

NATURE

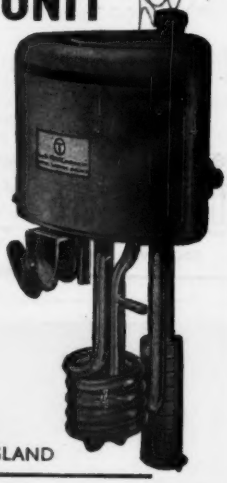
"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 178, No. 4525 SATURDAY, JULY 21, 1956 TWO SHILLINGS

TECHNE TEMPUNIT

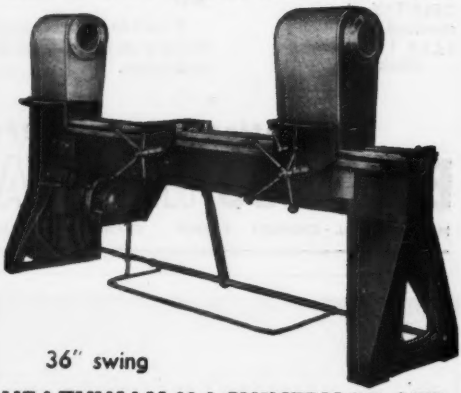
The Techne Tempunit is a self-contained constant temperature control for fitting to any vessel.

- ★ *Indicating Thermostat.*
- ★ *Patented pneumatic control.*
- ★ *±.05°C. in unlagged 3 gallon bath, @ 45°C.*
- ★ *Circulation to external apparatus.*
- ★ *Brushless silent motor.*
- ★ *Rugged solid drawn 1000 W heater.*
- ★ *Efficient stirrer.*



TECHNE (CAMBRIDGE) LTD
DUXFORD · CAMBRIDGE · ENGLAND

HEAVY DUTY GLASS WORKING LATHE



36" swing

HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDX.

MSE

"SUPERSPEED 20" CENTRIFUGE

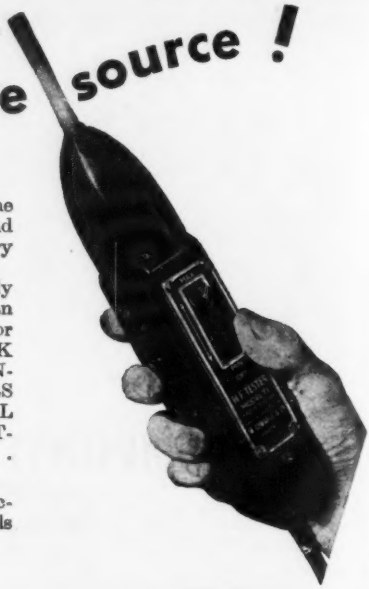
NEW

Push Button Control
20,000 R.P.M.
45,000 × g
Controlled Temperature

MEASURING & SCIENTIFIC EQUIPMENT LTD.
SPENSER STREET, LONDON, S.W.1. Telephone: VICtoria 5426

VACUUM INDICATION . . . VACUUM LEAK LOCATION . . .
TESTING CONTINUITY OF INSULATED LAYERS . . .

. . . from ONE inexpensive source !



EDWARDS High Frequency Testers, the simplest, most economical, foolproof and handiest little instruments for laboratory and factory.

Electrically safe . . . mechanically strong, continuous in operation, it can be comfortably held in one hand for VACUUM INDICATION . . . LEAK DETECTION . . . CHECKING CONTINUITY IN INSULATED LAYERS . . . BURNING OFF ELECTRICAL LEAKAGE DISCHARGE . . . EXCITING GAS-DISCHARGE LAMPS . . . ETC.

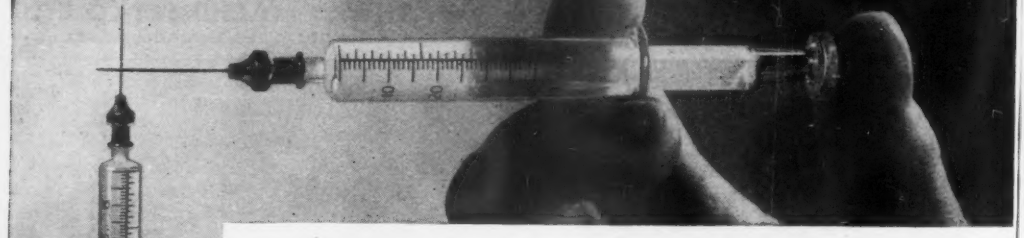
Flexible, interchangeable probes, electrically isolated from mains. Two models available.

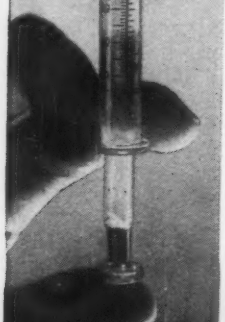
DELIVERY of standard voltages from stock

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY





planned precision from start to finish

In each batch of Chance Veridia Tubing the bore diameter is maintained to ± 0.01 mm. (0.0004 in.). Made from a heat-resisting borosilicate glass of low thermal expansion—Veridia is obtainable in a range of bore sizes from 0.06 mm. to 34.50 mm. A descriptive leaflet (OS14) will be sent on request.

Veridia is used for viscometers, gauges, micrometers, jets of controlled size, etc. When used in Syringe barrels, only slight internal grinding is required to produce a leak-proof fit.

Chance VERIDIA glass tubing
(REGD.)

CHANCE GLASS FOR SCIENCE, INDUSTRY AND THE HOME For information write to Dept. O.G.4.

Chance Brothers Limited • Head Office: Glass Works, Smethwick 40, Birmingham • London Office: 29/30 St. James's Street, S.W.1

NATURE

No. 4525 SATURDAY, JULY 21, 1956 Vol. 178

CONTENTS

	Page
A Centre for Geographical Research	109
Cleveland Abbe : a Pioneer American Meteorologist. By Sir Graham Sutton, C.B.E., F.R.S.	110
Prof. W. A. Heiskanen : Sixtieth Birthday Volume. By Dr. A. H. Cook	111
Detailed Reports on Nuclear Energy. By Dr. J. Walker	112
Genes, Species and Men. By Dr. E. H. Ashton	112
The Lower Primates and Evolution. By Sir Wilfrid Le Gros Clark, F.R.S.	113
Parasites of Livestock. By Dr. C. A. Hoare, F.R.S.	113
High-Energy Nuclear Physics. Moscow Conference : By Dr. T. G. Pickavance and T. H. R. Skyrme ; Geneva Conference : Dr. T. G. Pickavance and G. H. Stafford	115
Synthetic Detergents and the Treatment of Water and Sewage. By Dr. B. A. Southgate, C.B.E.	118
The Study of Man-made Fibres. By Prof. J. B. Speakman	119
Grassland Research Institute : New Research Buildings. By Dr. William Davies	121
Imperial College of Science and Technology, London : Revised Expansion Scheme	123
News and Views	124
A Numerical Calculation of the General Circulation of the Atmosphere	129
Industrial Applications of the Electron Microscope. By Dr. A. F. Brown	129
Hypotensive Drugs and the Control of Vascular Tone in Hypertension	131
The Motions of the Outer Planets	134
Population of British Universities in the 1960's. By Dr. Wallis Taylor	135
Successful Skin Homografts in Inbred Chickens. By A. G. Cock and Margaret Clough	136
Microscopical Measurements of Optical Path-difference by means of Coloured Birefringent Interferences and a New Compensation Method. By L. P. Johansson and B. M. Afzelius	137
Growth of Sucrose Crystals. By H. E. C. Powers	139
Letters to the Editors :	
Immunity of Lysogenic Bacteria.—Brigadier J. S. K. Boyd, O.B.E., F.R.S.	141
Role of Non-Protein Nitrogen in the Synthesis of Hæmoglobin in the Reticulocyte *in vitro*.—H. G. Schweiger, Prof. S. Rapoport and E. Schölzel	141
Recovery from Irradiation following the Administration of Cultured Tissues.—Dr. Carol L. Miller	142
Metabolism of Glycerol, Sorbitol and Related Compounds by Spermatozoa.—Dr. T. Mann, F.R.S., and Dr. I. G. White	142
Metabolism of Lysergic Acid Diethylamide.—Dr. Julius Axelrod, Roscoe O. Brady, Bernhard Witkop and Edward V. Evarts	143
Soil as a Habitat of Vitamin-requiring Bacteria.—Dr. A. G. Lochhead and Margaret O. Burton	144
Action of Pepsin on Synthetic Substrates.—Dr. N. M. Green ; Dr. Lillian E. Baker	145
Growth of Mouse Tumour in the Chick Embryo with Retention of Capacity by the Chick to form Antibody to the Tumour Cells in Later Life.—Dr. Howard Green and Allan L. Lorincz	146
Resting Tension in Snail Muscle.—Dr. B. C. Abbott and J. Lowy	147
Experimental Maturation or Ageing of Collagen in Rabbits' Ears.—Dr. B. Jolles, S. G. Greening, G. B. Dun and Pamela Tymms	148
Effect of Molybdenum Deficiency on Catalase and Peroxidase in *Neurospora*.—Dr. D. J. D. Nicholas	148
Cumulative Effect of Sub-Lethal Doses of Insecticides on Houseflies.—A. B. Hadaway	149
Interspecific Competition in Higher Plants.—Dr. J. K. A. Bleasdale	150
Toxicity and Breakdown of 'Hormone' Herbicides.—Dr. Wm. W. Fletcher and John C. Raymond	151
Impression Methods for the Study of the Distribution of Deposits and Organisms on Plant Surfaces.—S. H. Bennett and C. G. L. Furmidge	152
Lack of Christmas Factor in Horse Plasma.—Dr. Knud-Erik Sjølin	153
A New Blood Parasite in British Pigs.—A. R. Jennings and John Seamer	153
Unexpected Anomalies in the Behaviour of Neutral Red and Related Dyes.—Dr. Donald L. Vivian and Dr. Morris Belkin	154
Separation of Carbohydrates by Electrophoresis on Glass Filter Paper.—D. R. Briggs, E. F. Garner and Prof. F. Smith	154
Spectrum of the Cyclopentadienyl Radical.—Dr. B. A. Thrush	155
A Test of the 'Redox' Hypothesis of Active Ion Transport.—Dr. Alexander Leaf and Alan Renshaw	156
Formation of Hydroperoxides from Nucleic Acids by Irradiation with X-Rays in Aqueous Systems.—Dr. G. Scholes, Dr. J. Weiss and C. M. Wheeler	157
Influence of Surface Oxygen in the Activation of Carbonized Coals by a Partial Combustion.—J. R. Arthur, E. J. Newitt and M. M. Raftery	157
Solid-State Reaction in the System ZrO_2—Al_2O_3—SiO_2.—Dr. H. Fowler	158
Class II Radio Signals from Venus at a Wave-length of 11 Metres.—Prof. John D. Kraus	159
Diffraction of Light by Ultrasonic Waves at 300 Mc./s.—Dr. B. Ramachandra Rao and J. Satyanarayana Murty	160
Calibration of Vibration Pick-ups at High Frequencies using a Michelson Interferometer.—S. M. Davies	161
Inadequacy of Recombination as the Source of Light from Enduring Meteor Trains.—Gerald S. Hawkins and Allan F. Cook	161
Effect of Drawing on the Infra-red Dichroism of Nylon-66 Filaments.—Gino Caroti and Joseph H. Dusenbury	162
Biological Research in East Africa.—Hugh Copley ; Prof. J. N. P. Davies	163

DIFCO

BACTO-CEPHALIN CHOLESTEROL ANTIGEN

For Hanger Flocculation Test

An approved and stable reagent for use in the Hanger Flocculation Tests to determine disturbance of liver function. Available in packages of six units, each unit equivalent to 150 ml. final test antigen.

Hanger: J. Clin. Invest. **18**:261:1939.

BACTO-THROMBOPLASTIN

For Prothrombin Determination

A stabilized rabbit brain substance for use in determining the Prothrombin Time of Blood.

Bacto-Thromboplastin is applicable to the procedures described by Quick, Link-Shapiro, Smith, et al., Kato and Poncher, and other tests requiring a potent thromboplastin. Each box of Bacto-Thromboplastin contains 6 ampoules, sufficient for 210 Quick determinations or 420 Link-Shapiro determinations.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Great Britain

BAIRD AND TATLOCK (LONDON) LTD.

FRESHWATER ROAD, CHADWELL HEATH, ESSEX

Quality is more than just a word

. . . it signifies high standards and proven reliability, which merit your confidence.

- AMINO ACIDS: PEPTIDES
- "VITAMIN FREE" CASEIN HYDROLYSATE
- NUCLEOPROTEINS, PURINES, PYRIMIDINES
- MISCELLANEOUS BIOCHEMICALS
- VITAMINS
- ENZYMES
- GROWTH FACTORS
- STEROID HORMONES
- BIOLOGICAL SALT MIXTURES
- BIOLOGICAL TEST MATERIALS

Three days after your order is received it will be delivered in most parts of Europe.

NUTRITIONAL BIOCHEMICALS CORPORATION

21010 Miles Avenue • Cleveland 28, Ohio

U.S.A.

Write for new Catalog, July 1956. Over 1,700 items. Write Dept. 108

A CENTRE FOR GEOGRAPHICAL RESEARCH

IN his presidential address at the recent annual meeting of the Royal Geographical Society, General Sir James Marshall-Cornwall made a plea that the Society should become the focal point of geographical research in Britain. It is an idea which should be sympathetically received by the numerous departments of geography which now flourish in all our universities, and not least by the geographers in the different schools of the University of London.

The Society is, of course, generally known not for its contributions to research and education, not even for its services to the public as the principal centre of geographical information in Britain, but for its sponsorship of exploration, of a scientific as well as of an adventurous kind. But its efforts to promote research and education are at least as important a part of its long and distinguished history, especially its efforts to establish geography as an academic discipline in the universities throughout Britain. By the middle of the nineteenth century, the fortunes of geography, which had steadily declined in Britain since Elizabethan days, were at a low ebb. In 1848, the Prince Consort, newly appointed chancellor of the University of Cambridge, strongly deplored the fact that there was no provision for the teaching of geography to undergraduates of the University. The position at Oxford at that time was no better. An attempt had been made there in 1857 to found a Waynflete professorship of geography. But it was soon abandoned. Then the Society, led by a redoubtable president, the late Sir Clements Markham, stepped in and achieved remarkable success. With its help, financial and moral, a readership was founded at Oxford in 1887, and the year 1899 saw the establishment there of the first Department of Geography in Britain. Two years earlier, again with the Society's help, a lectureship in geography at Cambridge, dating from 1888, was converted into a readership, and a University Board of Studies in Geography, the embryo of the future Department, was set up in 1903.

In that year, according to the late Dr. Hugh Robert Mill, the Royal Geographical Society set up its own Research Department to co-ordinate lectures on technical subjects. This also served as a centre from which attention might be directed to problems of geographical research which the supervising Research Committee felt were of particular importance*. Land utilization, coastal morphology, soil erosion and other problems of the arid and torrid zones, microclimatology, the geographical pattern of disease, were some of the fields in which the Society set out, in those early days, to promote research. The contribution of the Society's own Research Department and Committee is not easy to estimate. But its full list of subjects to be studied covers most of the main lines of advance in geographical research since that time. Meanwhile, the Society's efforts to stimulate geographical education in the universities continued unabated. Between 1887 and 1924, it has been calculated*, more than £20,000 was contributed from its funds towards the establishment of geography as an enduring part of university education in Britain.

To-day, the Society is already, in some respects, on the way to becoming a centre of geographical research of the kind its president has in mind. Its excellent geographical library is predominantly used, not, as is sometimes supposed, by the dilettante reader of travellers' tales, but by undergraduate and postgraduate students. Its technical lectures and discussions provide a forum, not only for university geographers, but also for those working in the more specialized branches of science who are concerned with geographical aspects or the application of geographical techniques. Geography, so it seems, is essentially a co-ordinating, a bridging, study involving an appreciation and an interpretation of relationships against the physical background. To geographers the water-tight department should be anathema. Close contact must therefore be maintained by them with these specialist branches, since it is the latter which provide the source of material for geographical synthesis.

In these and in other ways, as in the continuous association which is maintained with geographical research workers abroad, as in its research publications and production of special maps, and in its promotion of field-work by expeditions, the Society is already fulfilling some of the functions of a centre of geographical research.

How else then could the Society fulfil the role outlined by General Sir James Marshall-Cornwall in his presidential address. With so much achieved, with so many facilities available, might not such a centre now be formally established in the Society as an institute of geographical research, associated perhaps with the University of London, but not, of course, confined to it? An institute of this kind, administered and financed jointly by the Society and the University, was proposed many years ago by the late Sir Halford Mackinder and outline plans were printed. There are parallels, indeed, more or less, in some of the existing institutes of the University; in the Institute of Commonwealth Studies which has some association with Chatham House; in the Institute of Classical Studies which is linked to, and uses the library of, the Greek and Roman Societies; in the Institute of Historical Research. The several

* "The Record of the Royal Geographical Society, 1830–1930", p. 147. (London, 1930.)

* "Geography as a Humane Study", p. 6. An inaugural lecture by Prof. E. W. Gilbert. (Oxford, 1955.)

geographical departments of the University are widely scattered over London. The scope of geography is diffuse; its need for a central point of contact with cognate branches of learning is very marked. The emphasis given to different aspects of geography by the different schools, both inside and outside London, varies considerably. These are all considerations which suggest that geography is a field of study which would derive special benefit from the establishment of a central institute to promote and co-ordinate advanced studies and research.

There were rumours some years ago that plans for just such a geographical institute—following up, no doubt, Mackinder's earlier plans—were to be considered by the University of London. If so, then the prospect of obtaining a suitable building and of forming afresh a library and map collection could scarcely have been encouraging. Nor would the project be easy to justify while there exists in London, in the Royal Geographical Society, the nucleus of such an institute with ample buildings of its own, with land adjacent for extensions, with an excellent specialized library, and a map collection unrivalled in Britain, and for that matter in Western Europe. It would surely seem better sense to make greater use of the facilities already available in the Society, and to adapt them as necessary for academic purposes, than to attempt to start afresh.

There should be no insuperable problem in supplying the other services which an institute of geographical studies should provide. With the co-operation of members of the geographical departments of the different schools of the University, seminars for advanced students could be held and instruction and supervision arranged. For a number of years towards the end of the nineteenth century, a studentship for geographical research was jointly offered by the Society and the University of Oxford. Once the Society had received formal academic recognition—and this would be the first important step—help might well be forthcoming from one of the great foundations towards the establishment of similar postgraduate studentships attached to the Society's research institute, including provision for field-work abroad. The administration of the institute might, it is true, pose some awkward problems. The Society is almost entirely financed from the subscriptions of its members, to whom it must have special obligations. But this again should not prove an insuperable obstacle. Some form of a joint committee with the University would probably provide an answer.

The Royal Geographical Society has, through its president, shown an evident desire to play a greater part in the promotion of geographical research by offering to include in its establishment a centre of advanced studies. It is a function for which in many ways it is ideally suited, and one for which it already has many material advantages. The Society has, implicitly at any rate, extended the invitation. It is now for the university geographers in London and elsewhere to respond, at least to the extent of showing signs of willingness to examine the invitation carefully.

CLEVELAND ABBE: A PIONEER AMERICAN METEOROLOGIST

Professor Abbe and the Isobars

The Story of Cleveland Abbe, America's First Weatherman. By Truman Abbe. Pp. xi+259+14 plates. (New York: Vantage Press, Inc., 1955.) 3.50 dollars.

CLEVELAND ABBE (1838–1916) has an honoured name in the history of meteorology as the man who, more than any other, created the United States Weather Bureau. This book, written by his son, the late Dr. Truman Abbe, gives the story of his life and recounts some of his struggles to bring into being and maintain an official weather service worthy of the name.

Abbe came of New England farming stock. As a young man, he studied astronomy at Ann Arbor and at Cambridge, Mass., after which he spent two years in Russia working under Otto Struve at Pulkova Observatory. In 1867 he returned to America, and in 1868 was appointed director of the dilapidated astronomical observatory at Cincinnati. The next year he began to publish daily weather reports under a loosely knit sponsorship of the Cincinnati Chamber of Commerce and the Western Union Telegraph Company. His first published forecast (he usually called them 'probabilities') was produced on September 1, 1869, and in his diary for the same day he wrote: "First prognostication. A Doubt and a Failure". The venture soon came to an end for lack of support, but it led to an Act of Congress providing for the use of the Signal Corps of the Army for the organization of a public weather service, in which Abbe filled the dual role of chief forecaster and what we should now call 'director of research'. The Signal Corps at that time, however, was not sympathetic to scientific work, and Abbe's enthusiasm and unfailing good nature often must have been strained to the utmost in his efforts to build up an efficient service. In 1891 Congress relieved the Signal Corps of its unwelcome task and set up the United States Weather Bureau in the Department of Agriculture, with Abbe as "professor of meteorology".

The new venture began well, but quickly ran into trouble. When, in 1893, the government changed hands, Abbe and others of the scientific staff were reduced in rank and pay, on the official but scarcely credible grounds of incompetence. From the account given in the present book this seems to have been entirely an act of political vengeance against men who had the misfortune to be appointed by the opposition party. Abbe did not regain his position and salary until several years later, when a new chief of the Bureau was appointed; but it is evident that throughout most of his long association with the Weather Bureau he was regarded as its principal scientific authority. Later, he travelled extensively, writing long letters home, and he did not resign his post with the Weather Bureau until a few months before his death, when he was nearly eighty years of age.

Abbe wrote voluminously and for many years was editor of the *Monthly Weather Review*. In addition, he published a noteworthy collection of translations of papers on dynamic meteorology entitled "The Mechanics of the Earth's Atmosphere", as well as books on instruments, forecasting, and the relation between climate and crops. It is somewhat difficult to assess the true scientific value of this large output,

which is scattered over so many periodicals; but it is probably fair to say that, although not a very original worker, he did as much as any man to bring the science of his day into official meteorology. Some extracts from his writings are given in this volume, and one cannot fail to be impressed by their integrity and clarity. His article on rain-making and long-range forecasting, for example, although published in the *Monthly Weather Review* as long ago as 1903, can still be read with profit. His talents were widely recognized in his lifetime, and probably nothing pleased him as much as the award of the Symons' Memorial Medal by the Royal Meteorological Society in 1912.

The present volume is not in any sense an 'official' biography, and it attempts no objective evaluation of his work as a meteorologist—a wise decision, seeing that the author was his son and a medical practitioner. It is little more than a collection of intimate sketches and anecdotes, loosely strung together and filled out with extracts from his letters and accounts of family matters, much of which is now rather dull reading.

But the impression left on the reader is clear enough—that of a kindly, deeply religious man who, by his integrity, enthusiasm and secure knowledge of the physics of his day, helped to lay the foundations of a great scientific institution. Even if his work had not the imprint of genius, like that of Bjerknes or W. H. Dines, his contribution to meteorology was exactly what was needed for the time. When he began, meteorology was little more than folk-lore; when he died, it had become a science.

O. G. Sutton

PROF. W. A. HEISKANEN: SIXTIETH BIRTHDAY VOLUME

Professori Weikko A. Heiskaselle hänen 60-vuotispäivänään omistettu juhlajulkaisu

Veröffentlichungen des Finnischen Geodätischen Institutes. Nr. 46. Pp. 214. (Helsinki: Suomen Geodeettisen Laitoksen Julkaisuja, 1955.) n.p.

PROF. W. A. HEISKANEN is well known among geodesists and geophysicists for his contributions to the study of isostasy and as director of the International Isostatic Institute of the International Union of Geodesy and Geophysics and research professor at the Mapping and Charting Institute of the University of Ohio; his many friends will be pleased that the Finnish Geodetic Institute has commemorated his sixtieth birthday by the publication of this volume of essays. The book is in two parts, the second of which, comprising five papers on the results of the 1945 solar eclipse expedition of the Finnish Geodetic Institute, will be read by all interested in the use of eclipse observations for geodetic position measurements.

Among the eighteen commemorative essays in the first part of the volume, four have a distinctively Finnish character. V. Erola describes the development of air survey in Finland, and K. G. Löfström discusses in detail the method of stereo-photographic triangulation, peculiar to Finland, in which the horizon is photographed by two horizontal cameras to determine the tilts of the vertical camera by which the ground is photographed; Errki Kääriäinen compares two different methods for calculating the uplift of the land from the results of the two precise geodetic levellings of Finland, and Heikki Tuori reviews the technical delimitation of territorial waters with reference to the particular problems of the Finnish coastline. The paper by Tauno Honkasalo, in which he describes some tests of height measurements with aneroid barometers with a mean error of 1·6 m., will be useful to others who have to make gravity meter observations in places where heights found by spirit-levelling are few or absent.

There are two essays on geophysical subjects. Prof. Gutenberg's calculations of pressure as a function of depth beneath high mountains, beneath continental lowlands and beneath the deep oceans, in which he uses the most recent evidence about the properties of materials down to 50 km., emphasize again that, even assuming that the granitic layer is really composed of granite of density 2·67 gm./cm.^{3}, the mean density of 2·67 gm./cm.^{3} for the upper layers usually postulated in isostatic calculations is too low and that existing isostatic anomalies calculated on the assumption of 2·67 gm./cm.^{3} do not represent the true disequilibrium in the crust of the Earth. E. Niskanen reviews the application of Bijlaard's theory of plasticity to the buckling of the Earth's crust, but his calculations do little more than confirm what Sir Harold Jeffreys has so often emphasized—that buckling, in its usual engineering sense of elastic instability, never occurs in the Earth's crust.

In view of Prof. Heiskanen's own studies, the papers that will probably be read with most interest are those dealing with the determination of the form of the geoid—the gravitational equipotential surface at sea-level. Dr. de Graaff Hunter puts forward a new proposal for finding the difference between the deflexions of the vertical at two intervisible sites from comparisons of the apparent optical elevation of each above the other when the height of each above the geoid is known, the essence of his proposal being a new way of eliminating the effect of atmospheric refraction by symmetrical observations. In his present position, Prof. Heiskanen is responsible for a large programme, having the object of calculating the detailed form of the geoid from gravity measurements by using an integral formula due to Stokes. One of the difficulties of such a project is that there are no gravity observations in large areas of the Earth, and the question of the effect of these areas on the calculated form of the geoid is discussed in two papers: one, by Prof. Hirvonen, on a spurious first-order harmonic term that may be introduced; and the other, by Prof. Vening Meinesz, on the estimation of the magnitude of the effect from plausible assumptions about the isostatic anomalies in the unsurveyed regions. An aspect of the theory of the application of Stokes's formula to the actual Earth is considered by Dr. Ledersteger, who calculates the effect of topography on the gradient of gravity between the surface of the topography and the geoid.

Most of the papers in this volume deal with topics of current interest, and none is within its limits inadequate; yet the collection as a whole leaves one disappointed. When such a collection is prepared, the reader may hope that, taken together, the subjects of the essay will give him a good idea of the important work in progress in the particular field; but the present collection does not do this, not even for current work in Europe, to say nothing of that in Britain or America. There is, for example, no paper on the problem of establishing a consistent world-

wide gravity network on which a great deal of work is being done, nor is there one from Prof. Heiskanen's own group in the United States dealing with any of the interesting work being done there.

Furthermore, anniversary volumes afford an opportunity for critical reviews or expositions of important new ideas, and again it must be said that, in this volume, the opportunity has been missed. This work does indeed do honour to a distinguished colleague, but the honour would have been greater had the anonymous editors conceived it on broader lines and encouraged their contributors to write with greater depth.

A. H. Cook

DETAILED REPORTS ON NUCLEAR ENERGY

Progress in Nuclear Energy

Series I: Physics and Mathematics. Vol. 1. Edited by R. A. Charpie, J. Horowitz, D. J. Hughes and D. J. Littler. Pp. x+398. (London: Pergamon Press, Ltd., 1956.) 84*s*.

THE Geneva International Conference on the Peaceful Uses of Atomic Energy released a welcome flood of information, and the long process of assimilation is now under way. This first volume of a series on the physics and mathematics of nuclear energy is largely devoted to helping the process by a number of critical reviews of the data presented at the conference, although some additional material is also included. Subsequent volumes, we are told, will be published as progress demands. The same plan for the first and later volumes is to be followed in the seven related series on reactors, process chemistry, technology and engineering, metallurgy and fuels, biological sciences, medical sciences and economics.

The striking feature of the first volume is its detail; these are articles for the expert to relish, not for the student to face. In some respects, however, the detail is fascinating for anyone: the elegant graphs in the article by J. A. Harvey and J. E. Sanders show scores of points from laboratories in many countries all lying snugly on smooth curves and explain why V. F. Weisskopf was stimulated by the Geneva Conference to write his foreword to this volume on the theme that science is international.

The Harvey–Sanders article on a summary of data on the cross-sections and neutron yields of uranium-233 and -235 and plutonium-235 and the associated one by P. A. Egelstaff and D. J. Hughes on their resonance structure form a valuable source of information on these important nuclei. H. A. Bethe's theoretical analysis completes a trio of reports on the fissile materials and gives the main conclusions to be drawn from the experimental data.

The volume becomes more general with an excellent survey of experimental techniques for measuring neutron cross-sections, but returns to the particular when dealing with the cross-section of xenon-135, the fission product which is so important as a reactor poison. G. R. Keepin's article on delayed neutrons emphasizes the important part they play in the control of chain reactions and gives extensive information on their energies, periods and abundances. In this and a later article and also in other recent publications the 'dollar' is used as a unit of reactivity; this seems to be inviting confusion with economics.

The articles mentioned so far are connected with the background information for reactor design. The last four articles deal with various aspects of complete reactors: S. M. Feinberg gives a detailed discussion of the methods used in the U.S.S.R. for the calculation of heterogeneous reactors; Dixon Callihan writes on homogeneous assemblies; the experimental and theoretical work with highly enriched reactors is described by H. Hurwitz and R. Ehrlich for intermediate and thermal energies; and that for fast reactors by J. Codd, L. R. Shepherd and J. H. Tait. The section on fast reactors includes a very interesting description of the Harwell experimental reactor, ZEPHYR, and some of the results obtained with it. These articles cover very recent work and show the beneficial effect which the Geneva Conference had on the release of information. Perhaps it is a little too much to expect that the next volume in this series will have a detailed article on fusion.

J. Walker

GENES, SPECIES AND MEN

Evolution, Genetics and Man

By Prof. Theodosius Dobzhansky. Pp. ix + 398. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 44*s*. net.

EACH phase of the development of evolutionary theory has been characterized by books and monographs dealing with various aspects of the field. Prof. T. Dobzhansky's main contribution has been a comprehensive study, first published in 1937 and now in its third edition, on "Genetics and the Origin of Species". His present book is intended to form a simple introduction to evolutionary studies, and to point out the "bearing of the topics discussed on human problems".

The introductory chapter deals with the continuity of life, and the author then enters into a discussion of the basic principles of genetics. This section occupies by far the greater part of the volume. It is developed along what have now become conventional lines to include accounts of the origins of genetic variability, the genetics of populations, the mechanics of natural selection, adaptation, and the formation of races and species. The principles elaborated in these first eight chapters are illustrated by instances of the rapid evolutionary changes that have taken place in domestic animals and plants.

Then follows a discussion of the 'principles' that have been developed empirically in the field of comparative anatomy. It is somewhat surprising that the author apparently makes little attempt to survey the theoretical background of this subject critically in the light of genetical findings. He does nevertheless point out that genes control biochemical processes during embryonic development rather than individual characters of the adult; but again, little mention is made of the new and relevant concepts that have been developed in the field of 'epigenetics'.

A chapter on the evolution of sex follows. This might have been more suitably placed in the earlier part of the book for, in its present position, it breaks the continuity between the discussion of the principles of comparative studies and the survey of the fossil record that follows.

The author deals rapidly with the main features of the evolution of the vertebrates, and as the text proceeds, less and less prominence is given to the genetic background. Finally, the reader is confronted with a not unduly critical account of the fossil remains

of man's presumed ancestors. Prof. Dobzhansky stresses that living men form one species, and concludes with a discussion of the evolutionary possibilities that are open to man as being the only animal capable of conceptual thought and therefore able to transmit culture.

There can be little doubt that, for many students, Prof. Dobzhansky's book will provide a stimulating introduction to the genetic basis of the biological variation on which selection acts. The unevenness of his work may well reflect the fact that the very size of the subject precludes any one scholar from being equally competent in all its branches. A companion volume providing an introduction to the elements of developmental genetics, and to the application of genetical principles to the study of palæontology and comparative anatomy, would prove a welcome addition to present-day evolutionary literature.

E. H. Ashton

THE LOWER PRIMATES AND EVOLUTION

The Non-Human Primates and Human Evolution

In Memory of Earnest Albert Hooton, 1887–1954. Arranged by James A. Gavan. Pp. v+134 (8 plates). (Detroit: Wayne University Press, 1955.) 3.50 dollars.

In a symposium at the annual meeting of the American Association for the Advancement of Science in 1953, a series of papers was presented on the relation of studies of the lower Primates to problems of human evolution. These papers were published in the issue of *Human Biology* for September 1954, and have now been republished in the form of a book dedicated to the memory of the distinguished American anthropologist, Dr. Earnest A. Hooton, who died in 1954.

While the title was no doubt suitable as an indication to the contributors of the main theme of their symposium, it is not altogether appropriate for this volume, since it implies to the prospective reader that the subject is treated with some degree of comprehensiveness and in logical sequence. In fact, the book consists of a number of short articles dealing with rather disconnected subjects, not all of which have a very obvious relation to immediate problems of human evolution.

Three essays on the study of behaviour in lower Primates will be found of more particular interest, for the reason that they present some original ideas which, it is suggested, may have a bearing on the mental and cultural evolution of the early Hominidæ. Dr. C. R. Carpenter advances tentative generalizations on the grouping behaviour in non-human Primates—generalizations which (he makes clear) are no more than hypotheses to provide a basis for future studies. Dr. H. W. Nissen discusses problems of mental evolution in Primates, and insists that there are no fundamental or qualitative differences between the emotions and motivations of man and the other Primates: "What especially characterizes human motivation is not its initiating goals, but rather the indirection and complexity of its approach to those goals". Finally, in an article by Dr. and Mrs. K. J. Hayes, an attempt is made to relate personal observations on a young chimpanzee (who spent the first six years of her life in their home) to speculations on the sequence of events which led to the development of cultural behaviour in human evolution.

It is a pity that two of the most interesting papers presented at the actual symposium—interesting because they deal with subjects about which there is so little published information—are only recorded in this book in the form of short abstracts: Dr. G. L. Jepsen, on the fossil Primates of the New World, and Dr. G. E. Erikson, on the comparative anatomy of the New World Primates.

W. E. Le Gros Clark

PARASITES OF LIVESTOCK

Veterinary Parasitology

By Dr. Geoffrey Lapage. Pp. xvi+964+34 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 63*s*. net.

While the medical man is adequately supplied with text-books on human parasitology in the English language, the veterinarian is less fortunately situated; for there are scarcely any modern books covering the field of animal parasitology, in spite of the economic and public health importance of parasitic diseases in livestock. There is therefore an urgent need for an up-to-date handbook dealing with the parasites and the diseases produced by them in domestic animals. No one could be better qualified to undertake this formidable task than Dr. G. Lapage, who has now provided teachers of animal parasitology and veterinary students with a comprehensive account of the protozoa, helminths and arthropods of veterinary importance.

Two introductory chapters are devoted to the general principles and concepts of parasitism, such as the types of animal associations, the characteristics of parasites, their life-cycles and methods of transmission, their effects upon the hosts and the reactions of the latter to infection. The remaining twenty-eight chapters are divided into four parts dealing (in the order that follows) with nematodes, flat worms, arthropods and protozoa. The description of the species considered in each of these phyla includes their systematics, morphology, life-history, host–parasite relations, control and drug treatment, illustrated by numerous text figures and plates. Among the arthropods are included—in addition to true ecto- and endo-parasites—also vectors of parasitic infections, as well as species which affect the health and well-being of livestock in other ways. Although the parasites are considered mainly from the zoological point of view, the course and epidemiology of the infections are described in some detail; but data on their therapy are only briefly mentioned, while diagnostic procedures are left out altogether. However, since this book does not claim to be a practical guide to clinical parasitology, and its size had to be kept within the bounds of a single volume, omissions could scarcely be avoided. Readers desiring to extend their knowledge of parasitology will find the necessary references in the bibliography, which occupies twenty pages. There is also a useful alphabetical index.

This authoritative and comprehensive text-book, which successfully fills the gap in the literature on parasitology, will be welcomed not only by veterinarians—for whom it is primarily intended—but also by medical workers and zoologists.

C. A. Hoare

A Supplement to the Catalogue of the Grace K. Babson Collection of the Works of Sir Isaac Newton and Related Material in the Babson Institute Library, Babson Park, Massachusetts

Compiled by Henry P. Macomber. Pp. viii+91. (Babson Park, Mass.: Babson Institute, 1955.) 4.90 dollars.

IN 1950 appeared the "Catalogue of the Babson Collection of the Works of Sir Isaac Newton", an ordered description of an important Newton library, housed in Babson Park, Massachusetts (see *Nature*, **166**, 284; 1950). The present "Supplement", compiled by Mr. Henry Macomber, the curator of the Collection and associate compiler of the original catalogue, lists a number of items of all kinds—books, reprints, manuscripts, photostats, photographs, portraits and so on—which have accrued to the Collection since the first catalogue was issued.

There are a few early books of high importance, such as copies of Huygens's "Horologium Oscillatorium", Kepler's "Astronomia Nova", l'Hospital's "Analyse des Infiniment Petits" and Hooke's "Micrographia"; but many of the acquisitions are in the way of recent writings about Newton, including reprints and extracts from journals. There are also a number of items of minor interest, in the case of some of which the Newtonian interest tends to be remote, as, for example, Hollar's etching of the Royal Exchange, made in 1644, which is a charming work, and an odd Vol. 1 of a two-volume edition of Boswell's "Life of Samuel Johnson", published in Philadelphia in 1841.

The work is produced uniformly with the original catalogue, all owners of which will certainly wish to acquire this supplement, which, incidentally, contains an errata list for the original volume.

E. N. DA C. ANDRADE

Progress in Organic Chemistry

Edited by Prof. J. W. Cook. Vol. 3. (Progress Series.) Pp. viii+273. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1955.) 45*s*.

THE third volume of this useful series certainly continues to enhance its reputation for providing up-to-date reviews of live topics. The first survey, on the total synthesis of steroids, by Dr. J. W. Cornforth, is that rarity—a comprehensive account of a complex subject written with clarity, modesty and humour. Every synthetic route is discussed and the story of this triumph of organic chemistry makes stimulating and enjoyable reading.

Since Prof. W. Baker's 1945 Tilden Lecture on non-benzenoid aromatic compounds, important new advances have been made in this field, and it is fitting that Prof. Baker (with Dr. J. F. W. McOmie) contributes to the volume a chapter on these compounds, which fully incorporates the recent work. This account is complemented by the succeeding chapter on the fulvenes, by Prof. E. D. Bergmann, which is a very full description of these interesting compounds.

The advantages of organo-lithium compounds over the more conventional Grignard reagents have been gaining recognition for some time. The chapter on organic compounds of lithium, by Prof. E. A. Braude, is therefore particularly timely and useful, and achieves a nice blend of practical and theoretical considerations. The pharmacological properties of reserpine have focused much recent attention on the yohimbine group of alkaloids. In the final chapter, on the indole alkaloids, Profs. V. Boekelheide and V. Prelog describe the modern investigations on this group and on other indole alkaloids, the unusual fine structures of which have been recently unravelled (the corynantheine, cinchonamine and erythrina alkaloids).

R. A. RAPHAEL

An Index of Mineral Species and Varieties Arranged Chemically

With an Alphabetical Index of accepted Mineral Names and Synonyms. By Dr. Max H. Hey. Second, revised edition. Pp. xxiv+728. (London: British Museum (Natural History), 1955.) 60*s*.

IT is five years since the British Museum (Natural History) issued the "Index of Mineral Species and Varieties", compiled by Dr. M. H. Hey (see *Nature*, **167**, 873; 1951). In the interval, much progress has been made in mineral chemistry, and the new edition of this valuable work of reference has been revised throughout by Dr. Hey. New information, up to March 1955, has been incorporated in the text, and last-minute addenda and corrections, up to April 1955, have been printed on four pages at the end of the book. The only other change is the addition of a "Pronouncing Index of Accepted Mineral Names", which has been included in an attempt to establish uniformity of pronunciation of mineral names in English-speaking countries—not an easy task; this index occupies sixty-six pages. Scientific libraries not already owning a copy of this work will no doubt welcome the opportunity to purchase it in its revised form.

Genetics in the Atomic Age

By Dr. Charlotte Auerbach. Pp. vii+106. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 8*s*. 6*d*. net.

A GROWING number of persons are becoming concerned about the genetic consequences of the exposure of human populations to radiation, but few are well informed about the scientific principles underlying the question. This little book has the timely purpose of helping to fill this gap for the non-biologist, and is admirably designed to do so. It is a model of lucidity and conciseness. Dr. Charlotte Auerbach, herself a first-rank teacher and investigator in genetics, presents the facts necessary for a grasp of the radiation question without recourse to ratios, equations or technical terms. Mutations, their effects, their hereditary transmission, and their evolutionary role are discussed in four chapters; the final two deal with the production of mutations by radiation and with facts relevant particularly to the human problem, and examine the nature of the consequences that future generations of mankind may suffer through exposure of the present ones to radiation.

The drawings by Miss I. G. Auerbach are most helpful, and have an original charm of their own. An appendix of scientific terms, not themselves used in the text but describing facts and ideas explained there, will assist readers who go on to more technical writings in genetics.

This book will do much to give its readers the knowledge necessary to judge wisely the genetic hazard due to radiation. Its obvious power to stimulate interest would make it a valuable addition to any biology class-room shelf or school library.

ALMA HOWARD

HIGH-ENERGY NUCLEAR PHYSICS

MOSCOW CONFERENCE

A CONFERENCE on high-energy nuclear physics was organized by the Academy of Sciences of the U.S.S.R., and the main sessions were held in the Lebedev Institute in Moscow during May 14–22. Although it was not officially described as an international conference, and physicists from the Soviet Union made up the majority of the six or seven hundred who attended, visitors from many other countries were also present as the guests of the Academy of Sciences. They included thirteen from the United States, seven from the United Kingdom, and others from the European Organization for Nuclear Research, Canada, Australia, France, the Federal German Republic, Italy, Norway, Sweden, Yugoslavia, Egypt, India, the Eastern European countries and China. It was an exciting occasion. Many laboratories were open to visitors, and it was possible to discuss physics freely with Soviet scientists at their work, as well as in the conference hall.

The programme was a very full one, with many relatively short papers in three sections usually running in parallel. The numerous formal contributions, and the large audience, often prevented adequate informal discussion of the papers except in the theoretical section. However, in the later stages, the anterooms and corridors began to fill satisfactorily with physicists engaged in discussion; there were always plenty of interpreters to assist, and many of the Soviet physicists spoke excellent English. The language difficulty was partially overcome in the formal sessions by the use of simultaneous translation from Russian into English; English-speaking contributors had to wait at short intervals for the Russian translation to be interposed. One speaker made his address in Chinese, which was translated by one of his colleagues into Russian and thence, by the official interpreter, into English.

Accelerators

In the first session, opened by M. G. Mescheryakov, the most important Soviet high-energy accelerator projects were outlined by A. L. Minz, V. I. Veksler and V. V. Vladimirsky. The accelerators described were the 6-metre synchrocyclotron, which has been operating since 1949 at 480 MeV. and since 1953 at 680 MeV., the 10 GeV. proton synchrotron now nearing completion, a 6–7 GeV. alternating-gradient proton synchrotron, and a projected 50-GeV. alternating-gradient proton synchrotron. More detailed reports on these machines were given in the accelerator sessions proper; but in addition, papers were presented on practically every known method of acceleration of particles to high energy and on experimental techniques. Of the sixty papers read, all but seven were Russian. There has been a great upsurge of activity in high-energy accelerator development during the past few years, but the Soviet effort in this field, revealed in full for the first time, is on a very massive scale by any standard.

We visited the Institute for Nuclear Problems, situated about 120 km. north of Moscow near the junction of the Volga with the Moscow–Volga canal, to see the two large accelerators. The Institute also contains a high-flux reactor and a heavy-ion accelerator, and is being built into a major centre for all aspects of nuclear physics under the direction of Blokhintsev. It is understood that ultimately it is to be an international centre, with eleven Communist States invited to share the facilities free of charge; we were told that physicists from Western countries would also be able to work there.

Both accelerators impressed by the excellence of their engineering. Of particular interest was the radio-frequency system of the 6-m. synchrocyclotron; this appeared, to those of us with experience in the field, the most elegant we had seen. Moreover, the reported operating data put the system ahead of all others known to us in respect of reliability and performance. The experimental enclosures attached to the synchrocyclotron are well shielded and very large in area, and contained more apparatus, such as analysing magnets and equipment for particle detection, than we had seen in any other single installation. Here again the quality was excellent, but in some respects did not match the standard set by the machine itself; for example, the external proton beams had to travel considerable distances in air after emerging from a metal window in the vacuum chamber.

The larger machine, the 10-GeV. proton synchrotron, was nearly complete. Final assembly and adjustments were expected to be completed by the end of 1956. The magnet contains 35,000 tons of steel; but, contrary to some reports, is not at all extravagant in this respect for an energy of 10 GeV. in a constant-gradient machine.

The new alternating-gradient machine now being designed, for 50-GeV. protons, may not be built on the Volga site. It was described in a number of papers by V. V. Vladimirsky and his colleagues. Similar machines of 30 GeV. and 25 GeV. are in a rather more advanced stage at Brookhaven and the European Organization for Nuclear Research respectively, but the Russian group has made an original contribution whereby the transition energy phenomenon, requiring a change of the stable phase of the particles, may be avoided at the expense of a 20 per cent increase in orbit-path and weight of steel. This proposal may have limited practical value, however, because recent work at Brookhaven has shown that the transition point may be passed safely with the help of careful design and accurate control.

A symposium on high-energy proton linear accelerators was held at the Moscow Physical Institute (of which I. V. Kurchatov is director). A group in Prof. Artsimovitch's department there had become interested in the design study carried out at the Atomic Energy Research Establishment, Harwell, in which one of us (T. G. P.) was closely concerned, and had begun studies of their own. They stated their intention to construct a 1,000-MeV. machine of this type. An exciting programme in the same Institute is being conducted by a team under G. I. Budker. This involved the production, in an apparatus of betatron type, of an intense circulating beam of relativistic electrons, 'pinched' by neutralization of the space charge by the introduction of positive ions. Inside this electron beam there may exist intense magnetic fields with a spatial configuration such that stable orbits of high-energy protons may be set up. The protons may be accelerated by the application of radio-frequency fields. If successful, this project could lead to the construction of an accelerator for 100 GeV. with an orbit radius of 3 m.; but it is of fundamental interest in any event.

Experimental Results

The first section of the main session was devoted primarily to the presentation of experimental results, with some papers discussing their theoretical interpretation. Very many of the papers presented by the Soviet physicists described work that has been done with the 680-MeV. synchrocyclotron; with the nucleon and π-meson beams from this machine, they have been able to extend to higher energies knowledge of the cross-sections for the elementary scattering processes.

While for energies up to 300 MeV. most of the possible elementary experiments on scattering of nucleons have now been made, so that a phenomenological interpretation in terms of phase-shift is becoming clear, the more complex situation at energies up to 600 MeV., with the competition of the inelastic meson-producing events, is still far from being completely understood. Soviet physicists described preliminary work on the polarization of scattered nucleons at these energies, which will give some of the extra clues needed. Neutron–neutron scattering has been investigated with the help of deuterium targets, and the evidence supports the belief that the scattering should be the same as for protons on protons, as is already well known at lower energies. The scattering of π-mesons has now been explored up to 300 MeV., but the new data are insufficient to yield any fresh information about the interaction of mesons and nucleons.

Other sessions were devoted to photonuclear reactions, and to new particles. In the latter, A. I. Alikhanyan produced evidence for the existence of a new meson; in an analysis of the masses of cosmic-ray particles he found, in addition to groups corresponding to μ-, π- and *K*-mesons, a clearly separated group (twelve events) of particles with a mass of 560 ± 120 electron masses.

In addition to the papers by Soviet physicists, there were a number of papers presented by the visitors, especially those from the United States, surveying recent and current work on the same topics in other institutes.

Field Theory and Related Matters

There were four sessions devoted to field theory and other technical theoretical matters. These naturally did not command so large an audience as those in the main section, but the sustained interest of a large number of young Soviet physicists was remarkable. Several of the papers presented related to the question of the utility of field theory; a subject which also overflowed into the main section. One extreme point of view, strongly advocated by L. D. Landau, I. Ya. Pomeranchuk and others, contends that the theory is nonsense because a logically consistent discussion of the solution of the equations appears to lead to the absurd conclusion that there is no interaction at all between different fields. Against this it is contended, not only that this conclusion has not been proved rigorously, but also that, in meson physics, the field theoretical ideas have proved to be qualitatively correct in many respects, and should be retained as a guide until a better theory can be formulated.

Among the applications of field theory there was discussion about the formulation and use of 'dispersion relations' for the scattering of nucleons; at present there is no simple way of using these, analogous to their successful employment in the discussion of meson scattering.

The discussions at this conference, and the close personal contacts made at many levels, were very encouraging for future international collaboration in scientific work. There appears to be reason to hope that they will be followed, not only by further conferences in which East and West will co-operate, but also by individual visits and by correspondence on matters of common interest.

T. G. Pickavance
T. H. R. Skyrme

GENEVA CONFERENCE

THE symposium on High Energy Accelerators and Pion Physics, organized by the European Organization for Nuclear Research (C.E.R.N.), was held in the Institute of Physics of the University of Geneva during June 11–23. Although some of the participants had attended the Moscow Conference, and a few of the papers were repeated, the great majority of the papers were heard for the first time. There were representatives of all the twelve member States of the Organization, about fifty each from the United States and the U.S.S.R., and others from Australia, Canada, Czechoslovakia, India, Spain and the United Nations Educational, Scientific and Cultural Organization.

High-Energy Accelerators

The first week was devoted to high-energy accelerator problems, with the emphasis on new ideas rather than recitations of lists of parameters. Authors of main papers, of 30 min. duration, had been invited to submit texts well in advance for reproduction and distribution by the Organization, and nearly all of them had co-operated. This procedure lends itself well to accelerators, development of which takes years of effort by large teams, though less well to experiments in physics. Many authors had taken the opportunity to write up their work in considerable detail and at greater length than could be accommodated in a half-hour talk. The conference 'preprints' were therefore very useful documents, and greatly aided discussion after the formal presentation of papers. Ample time was left for informal discussion, and there were no parallel sessions.

Main papers were presented by the Middle West (MURA) Group from the United States (D. W. Kerst, K. R. Symon, L. W. Jones) on the new fixed-field alternating gradient machines (FFAG). The object of the MURA project is to accelerate protons to energies of 15 GeV. or more, in a ring-shaped magnet energized by direct current and accommodating a large range of particle momenta in a small range of orbit radii. A disadvantage of normal synchrotrons, whether of constant gradient or alternating gradient type, is that the rate of repetition is limited to a low value by the problem of cycling the magnetic field; this difficulty is absent from machines of fixed-field type, and much higher intensities are hoped for. However, it is necessary to introduce azimuthal variations of magnetic field, and there are severe fundamental difficulties in establishing a stable system of particle dynamics. High-intensity operation also poses serious radio-frequency and phase-stability problems. All these matters were

discussed, together with a proposal by the MURA group to combine the beams of two such accelerators so that protons travel in opposite directions before collision. The energy liberated in the centre of mass system of co-ordinates would then be 30 GeV., for two 15-GeV. accelerators, and this would correspond, in the usual system where the target proton is at rest, to a bombarding energy of about 600 GeV. However, very high beam intensities would be needed for a useful yield of collisions.

Colliding-beam systems have been discussed for many years, but efforts are now beginning to be made to discover means of making them more plausible. There was much discussion of 'storage rings', for example, by W. M. Brobeck (Berkeley) and G. K. O'Neill (Princeton). A pair of these could produce colliding beams in a common sector, the rings being fed alternately by a single high-energy accelerator. Some of the informal discussion entered the realms of fantasy, but it was very stimulating.

Fixed-field alternating gradient systems may also be applied to cyclotrons, and a main paper by the Harwell group (T. G. Pickavance) discussed studies of machines of that type for high-intensity operation at about 3 GeV.

Three important Russian papers were presented on 'new ideas'. A. Naumov reported the work of Budker on relativistic stabilized electron beams (previously reported in Moscow). V. I. Veksler, in a most interesting contribution, speculated upon the possibility of accelerating particles in dense bunches using the field between a bunch and another group of charges, a plasma, or an electromagnetic wave. Such methods Veksler called 'coherent', because the force on a single particle would be proportional to the number of particles in the bunch. One possibility would be to exploit an 'inverse Cerenkov effect', according to which a medium, travelling rapidly past a charged particle, imparts energy to the particle. Ya. B. Fainberg discussed a system in which a plasma could be made to act as a wave-guide, particles being accelerated by an applied radio-frequency field. Phase and radial stability could be achieved and power losses would be less than those experienced with ordinary metal waveguides.

The remaining accelerator sessions dealt mainly with problems of existing machines or machines under construction. Papers on phase transition, radio-frequency acceleration injection, and extraction were presented by members of the Brookhaven, CERN and Russian groups concerned with the large alternating-gradient proton synchrotrons, and on magnet problems by the same groups and by M. Bruck (Saclay), J. M. Blamey (Canberra) and D. W. Kerst (MURA). There was a session on the important topic of non-linear betatron oscillations, in which main papers were read by R. Hagedorn (CERN), E. D. Courant (Brookhaven), A. A. Kolomenski (U.S.S.R.) and K. R. Symon (MURA), and another on linear accelerators with contributions from Brookhaven, Harwell, Kharkhov, Berkeley and Stanford. L. W. Smith (Brookhaven) and E. J. Lofgren (Berkeley) reviewed the operational problems of the 3-GeV. cosmotron and the 6-GeV. bevatron, respectively. These two great machines have now become organized facilities for research; the scale of organization required impressed everyone at the conference. For example, the bevatron requires the full-time services of nearly eighty people, from graduate physicists and engineers to craftsmen and technical assistants, not counting the research workers engaged in experiments. A degree of organization, at one time considered foreign to fundamental research, has therefore to be applied to the research programme; this is a difficult problem.

The accelerator sessions were most lively and successful, and it was noteworthy that the informal discussion was maintained at an exceedingly high standard to the end. Accelerator studies have developed into a branch of learning in their own right, and the conference showed that many laboratories in many countries are making vital contributions to this rapidly advancing field.

Developments in Technique

The first one and a half days of the second week were devoted to discussions of developments in technique. An introductory talk by D. A. Glaser, of the University of Michigan, on bubble chambers was followed by seven other papers on the subject from laboratories in France, Italy, the United States and the U.S.S.R. Attempts to improve the cycling time of cloud chambers were discussed by British and American groups.

In a review of recent advances in millimicrosecond-counting techniques, O. Chamberlain (University o California) mentioned the production of an experimental transmission type of photomultiplier by Sternglass and Wacktel, of the Westinghouse Research Laboratories. In one design the multiplying electrodes consist of gold foil 20 A. thick followed by a layer of potassium chloride 450 A. thick. The tubes require a few kilovolts per stage, and with seven stages of multiplication yield pulse-rise times of less than 1 millimicrosecond, but at the present stage of development they suffer from severe fatiguing troubles. A new R.C.A. tube (type number 6810) is, however, commercially available and this has the advantage of an output of 0·3 amp., so that for many applications it is possible to dispense with further amplification. By limiting the area of the photocathode it is possible to get rise-times as short as 1·5 mμsec.

One afternoon of the conference was devoted to the presentation and discussion of experimental results. It is perhaps a significant pointer to the future that pride of place was given to a session entitled "Antiproton Physics". E. Segrè gave a review of the antiproton work at Berkeley. For the time being, antiprotons have been produced only by proton bombardment of copper targets in the bevatron. From a study of stars produced by the interaction of antinucleons with matter, it has been determined that some stars show a visible energy release greater than Mc^2, which is proof that the antiproton is annihilated with a nucleon. It is not yet known whether the mechanism of production is a nucleon–nucleon collision producing an antinucleon–nucleon pair, or whether an intermediate step involving the production of a π-meson is required.

Interaction cross-sections in beryllium and in copper have been measured and found to be about twice the cross-section for protons. A possible explanation of this unexpected result has been given by Duerr and Teller (*Phys. Rev.*, **101**, 494; 1956).

Another striking event of the conference was an announcement by Prof. W. Pauli of news from the United States that the well-known inverse beta decay experiment of Cowan and Reynes had yielded a positive result, compatible with a cross-section of about 6×10^{-44} cm.^{2}. Evidence for the existence of the neutrino has thus been established.

Meson Physics

Most of the remaining sessions were devoted to meson physics. This was a deliberate policy on the part of the organizers of the conference, who had in mind the experiments that will be carried out on the C.E.R.N. synchrocyclotron (due for completion in 1957). The continued great interest in this important field was illustrated by the large number of interesting papers presented from many laboratories. It must suffice to summarize the proceedings by saying that many experiments gave supporting evidence for the existence of an isobaric state of the pion–nucleon system and of such a state in the charged-pion production process.

An elegant experiment outside the field of meson physics was reported by R. Hofstadter, on the structure and size of the proton. This experiment was carried out by measuring the angular distribution and differential cross-section for the scattering of high-energy electrons by protons. At large angles and high energies, the cross-section for scattering deviates from that expected for a point proton by about a factor of nine. The results fix the root mean square radius of the proton at $0{\cdot}77 \pm 0{\cdot}10 \times 10^{-13}$ cm. for each of the charge and momentum distributions.

There were visits to the CERN site at Meyrin, near the French frontier. It was most encouraging to see the great progress made on the construction of the elaborate foundations and ring building of the 25-GeV. machine. Construction of the 600-MeV. synchrocyclotron appeared to be well advanced. The whole conference was well organized and was a good augury for the continued vitality of this absorbing field of study.

T. G. Pickavance
G. H. Stafford

SYNTHETIC DETERGENTS AND THE TREATMENT OF WATER AND SEWAGE

Since 1949 there has been something like a three-fold increase in the sales of synthetic detergent mixtures in Britain, the majority of which contain as their most important constituent anionic surface-active agents of the alkyl aryl sulphonate type. Although these substances are used to some extent in industry, the big expansion in their sale during the past ten years has been for domestic purposes. Thus most of the synthetic detergents now used in Britain are discharged by the housewife to the sewers of local authorities and, except in some coastal towns, eventually pass to a sewage-disposal works.

Domestic sewage is normally treated by sedimentation and biological purification, and although the methods used may appear to the uninitiated as somewhat crude and primitive, they are in fact extremely efficient and capable of effecting a high degree of purification at a remarkably small cost. They are, however, rather easily upset by the presence in the sewage of certain types of substances, particularly those which interfere with microbiological processes, this being the main reason why it is often difficult to treat sewage in an industrial district where large quantities of trade effluent are discharged to the sewers. During the past few years there has been a growing feeling that household synthetic detergents are among the substances which cause difficulties at sewage works. Moreover, it is known that part of the surface-active agent they contain often passes through a treatment plant and so is discharged with the effluent to a river. It is common knowledge that during the past few years there has been a marked increase in the extent to which foam is formed on polluted rivers, particularly at places where they pass over weirs, and this again is commonly attributed to the presence of the surface-active materials in the water. In some parts of Britain rivers to which sewage effluents have been discharged have to be used as a source of raw water for domestic supply, and there has therefore been some anxiety as to whether surface-active agents may persist throughout a water-treatment plant and so be present in the supply distributed to a town, particularly since this is known to have occurred during exceptionally dry weather in at least one place in the United States[1]. For these reasons the Minister of Housing and Local Government some time ago set up a committee under the chairmanship of Sir Harry Jephcott to study the subject; its report has just been published[2]. A few weeks ago also the Association of American Soap and Glycerine Producers (who make synthetic detergents), through a report prepared by F. J. Coughlin, chairman of the Association's Technical Advisory Sub-Committee on Research, has made available the results of its own observations on the position in the United States[3].

The report of the American Association gives the impression either that the effects of detergents are not so marked in the United States as they are in Great Britain, or that if they are the Association has not fully appreciated the difficulties that have been caused. It is certain that at many sewage works in Britain, and especially at those using the activated-sludge process, frothing has increased during the past few years to a point at which operation of the plant is made very difficult, and in some cases dangerous, and that this frothing is due to the presence of surface-active constituents of synthetic detergents in the sewage; indeed, the British report includes two photographs of frothing at sewage works, at one of which the layer of foam appears to be several feet thick. The American Association, while agreeing that frothing has increased in the United States, does not appear to accept that detergents are the cause of it. It says also that frothing on the surface of aeration tanks and activated-sludge plants can be stopped by increasing the concentration of activated sludge in the mixture aerated. This was not found to be so in Britain, where experiments were made, at the suggestion of Sir Harry Jephcott's Committee, at several sewage works without any marked success. An important point of principle is, in any event, involved here; the processes used at sewage works have been evolved from experience and experiments over many years and the conditions at any particular plant are chosen to bring about the most effective purification of the sewage. It is very rarely that they can be drastically changed merely to prevent some

difficulty caused by the discharge to the sewers of some strongly interfering substances whether of domestic or industrial origin.

Where an effluent which would seriously interfere with sewage treatment is discharged to the sewers from a factory, it is very often required (legislation being available to enforce this) that it should be pre-treated by the manufacturer to remove the most noxious constituents. For example, effluents from electro-plating works are often treated in this way to remove cyanides and toxic metals. It is clear that washing waters containing synthetic detergents cannot be pre-treated by the housewife; but an obvious suggestion is that manufacturers of these substances should endeavour to produce materials which, though satisfactory for washing purposes, would be readily decomposed by the processes, including microbiological processes, commonly used at a sewage works. Difficulties in sewage treatment would thereby be greatly reduced, and the material would not be discharged with sewage effluent to rivers. Thus, any risk there may now be of constituents of detergents persisting in potable water supplies would be removed. Another important reason—not mentioned in the American report—is that it is known that surface-active agents in a river may seriously reduce the rate at which atmospheric oxygen dissolves in it[4]; it would be expected, therefore, that they would accentuate the de-oxygenation of a river containing a given amount of polluting matter.

One of the recommendations of the British report is that manufacturers of household synthetic detergents should investigate the possibility of producing efficient washing products based on materials which can be readily oxidized or eliminated when treated at a sewage works. The American industry also accepts that research of this kind is necessary and is sponsoring work at the Massachusetts Institute of Technology. Preliminary work in Britain[5] has shown that the resistance of alkyl benzene sulphonates to bacterial attack is correlated with the nature of the alkyl group, straight-chain compounds being much more readily decomposed than those with branched chains. The development of readily decomposable substances with the necessary detergent properties, and which could be economically manufactured from available raw materials, might obviously require lengthy research, but should surely yield to the combined attack of the organic chemist and microbiologist.

The question arises whether the public interest is sufficiently safeguarded while research of this kind is being carried out. It is reported that in 1955 a Bill was introduced in the Kansas Legislature which would have made it unlawful to put detergents into a public sewer. The British Committee has not recommended anything like such drastic action. The majority, however (four members dissenting), considered that there is at least a possibility that a serious situation might arise before a practicable remedy has been found. It points out that there are at present no statutory powers for controlling the composition of detergents sold to the public and recommends that the Government should consider whether to seek these powers now or to defer obtaining them until a clear need for them has arisen. It recommends also that in the meantime an advisory body, including representatives of the sewage authorities and manufacturers concerned and of appropriate Government departments, should be set up to give counsel and facilitate research, and to keep watch on the position at sewage works, on rivers, and at water works, in relation to the continued use of synthetic detergents of the type at present being manufactured.

B. A. SOUTHGATE

[1] Gallaher, W. U., *J. Amer. Water Works Assoc.*, **42**, 22 (1950).
[2] Ministry of Housing and Local Government. Report of the Committee on Synthetic Detergents. Pp. 60. (H.M. Stationery Office, London, 1956.) 3*s.* net.
[3] F. J. Coughlin, "Detergent Research Related to Water and Sewage Treatment". Pp. 17. (From the Association of American Soap and Glycerine Producers, Inc., 295 Madison Avenue, New York 17.)
[4] Gameson, A. L. H., Truesdale, G. A., and Downing, A. L., *J. Inst. Water Eng.*, **9**, 571 (1955).
[5] Hammerton, C., *J. App. Chem.*, **5**, 517 (1955).

THE STUDY OF MAN-MADE FIBRES

By PROF. J. B. SPEAKMAN
Department of Textile Industries, University of Leeds

A NEW building for the Man-made Fibres Division of the Department of Textile Industries of the University of Leeds was opened by the Duke of Edinburgh, in the presence of the Chancellor of the University, the Princess Royal, on June 29. Besides being the crowning point of some fourteen years endeavour in the Department of Textile Industries, the opening ceremony marks the beginning of a striking new period of expansion of the Faculty of Technology in a University which was already remarkable for its strength in the field of applied science.

The new Man-made Fibres Division is the direct outcome of the scientific revolution which the textile industry has undergone during the past forty years. Not only has this period seen the emergence of a science of fibres, based on the discovery of the main features of the constitution and structure of the chief natural fibres, with simultaneous rapid advances in the production of regenerated fibres from cellulose, cellulose acetate and proteins, but also the study of polymerization reactions has led to the synthesis of fibre-forming polymers and the manufacture of truly synthetic fibres.

Changes as profound as these could not, of course, take place without affecting the nature and scope of the training of the textile technologist; but progress seems to have been handicapped by the traditional structure of the textile industry in the United Kingdom. Regional segregation of industries based on the different natural fibres led to corresponding specialization in the main educational centres. Just as the University of Leeds focused attention on wool, so other institutions gave chief place to cotton, silk, flax or jute. Although the growing importance of man-made fibres has everywhere been recognized, pride of place is normally given to the natural fibres with which the institutions are traditionally associated,

Photograph by W. Blackledge, University Photographer

Fig. 1. Man-made Fibres Division, Department of Textile Industries, University of Leeds

and the man-made fibres are relegated to a second place bearing little relation to their importance in the national economy.

The magnitude of the man-made fibre industries may be gauged from the fact that, in 1954, the world production of regenerated fibres was about one-quarter of the world production of cotton and nearly double that of wool, while the production of fibres from synthetic polymers, which was negligible in 1935, was six times that of silk. Considerations such as these make it obvious that there must be at least one institution in the United Kingdom where the study of man-made fibres is not subordinated to that of natural fibres—one where textile technologists can receive specialized training for the industries which are engaged in making and using man-made fibres.

A project of this kind was conceived in 1942, and conversations were then begun with the directors of Courtaulds, Ltd., about the possibility of establishing a Man-made Fibres Division of the Department of Textile Industries in a new building near the Cloth-workers' Departments of the University of Leeds, now the Wool Division. Immediate action was impossible because of the War, but with characteristic generosity Messrs. Courtaulds made a donation of £60,000 towards the cost of the building in 1947. This donation was followed by one of £40,000 from the Man-made Fibres Producers' Committee in 1949. By then, plans for the new building (Fig. 1) had been prepared by Dr. T. A. Lodge, the University architect; but the estimated cost was far higher than the sum available, building permits were difficult to obtain, and the shortage of labour was acute. In 1952, however, a grant of £201,000 was made by the University Grants Committee to cover the balance of the estimated cost, and work was begun in July 1953.

The Department of Textile Industries at Leeds has been fortunate also in receiving further generous donations towards the cost of equipping the new Division. These include £25,000 from the Man-made Fibres Producers' Committee, £20,000 from Imperial Chemical Industries, Ltd., £7,000 from the Federation of Calico Printers, and £5,000 from the Tootal Broadhurst Lee Co., Ltd., as well as £70,000 from the University Grants Committee. In addition, machines and other equipment have in many cases been supplied free or at reduced cost by the makers.

As may be seen from the photograph, the new building has four floors and a semi-basement. As regards machinery, the key floor is the first. Here, along the north wall, is housed pilot plant for demonstrating methods of producing viscose and cellulose acetate rayons, nylon, 'Terylene' and orlon. Cotton carding and spinning machinery for converting staple fibre into yarn is housed in an adjoining room in the centre of the building, and continuous filament and staple fibre yarns are converted into woven and knitted fabrics in rooms on the west and east walls, respectively. The carding and spinning, weaving,

and knitting rooms are all provided with equipment for maintaining atmospheres of constant relative humidity. From the first floor the fabrics pass to the ground floor for dyeing (east end), printing (west end) and finishing (north wall). The ground floor includes also a dark room for the preparation of screens for screen printing, and two humidity rooms in which textile testing equipment is housed, one room being for use by undergraduates and the other for research students. On the second floor are two large laboratories for practical work in textile chemistry and textile physics by second- and third-year undergraduates, and the third floor includes a well-lighted design studio, for use mainly by students specializing in textile design, and two lecture theatres. Research laboratories are provided on the south side of each floor: in the semi-basement, for textile physics (electron microscopy, infra-red spectroscopy and X-ray analysis of fibre structure); on the ground floor, for applied chemistry (dyeing and finishing); on the first floor, for textile engineering; on the second floor, for textile chemistry; and on the third floor, for applied physics and textile chemistry (chemistry of high polymers).

In accordance with the 1942 plan, therefore, the Man-made Fibres Division is self-contained. It possesses equipment covering all stages of processing from fibre to fabric and confirms the rising stature of the man-made fibre industries. The advantages attached to the creation of the new Division have not, however, obscured its dangers. There is a unity in the science of fibres which transcends divisions, and there is so much common ground and interplay between the various branches of textile technology that division is dangerous. For these reasons, the Wool Division and the Man-made Fibres Division are to be regarded as complementary. Together they provide unrivalled opportunities for teaching and research, and all members of the staff will have responsibilities in both Divisions. Similarly, undergraduates will make use of both Divisions in the early years of their courses, leaving specialization in either wool or man-made fibres to the final year. In this way the unity of the science of fibres will be preserved and the growing unity of textile technology promoted.

In his address at the opening ceremony, the Duke of Edinburgh stated that "This new building can only be justified if the Man-made Fibres Division has constantly in mind that its work can be of direct service to the country. . . . The Division cannot possibly flourish without the active and continued interest of the industry, and I would go further and say that the Division will only be kept up to the mark if the industry makes sudden and impossible demands upon it". The close and cordial relationships between the Department of Textile Industries and the industries it serves ensure that such demands will be made and the high hopes entertained of the new Division realized.

GRASSLAND RESEARCH INSTITUTE: NEW RESEARCH BUILDINGS

By Dr. WILLIAM DAVIES
Director

THE new research laboratories of the Grassland Research Institute at Hurley, Berkshire, were opened by the Right Hon. D. Heathcoat-Amory, Minister of Agriculture, Fisheries and Food, on June 29.

The Institute was founded in 1949 for the investigation of grassland and of the many problems associated with the production and use of pastures by the grazing animal. The governing body is under the chairmanship of Sir James Scott Watson and consists of scientists and practising farmers, who are appointed by the Ministry of Agriculture, Fisheries and Food, the Secretary of State for Scotland and the Agricultural Research Council, the latter being responsible for the scientific supervision of the Institute, which takes its place among the other grant-aided research stations operating under the scientific guidance of the Agricultural Research Council. The Grassland Research Institute was preceded by the Grassland Improvement Station, established in 1940 at Drayton (near Stratford-on-Avon) under the inspiring leadership of Sir George Stapledon. In 1949 the new Institute took over the functions, facilities and staff of its forerunner, but since that time has considerably extended in terms of both staff and facilities. The new research buildings at Hurley have been in full occupation since the autumn of 1955 when, for the first time, the scientific staff had the very real advantage of working together at a single centre with adequate laboratory and field facilities.

The opening of the new laboratories marks, therefore, the end of the first important phase in the development of the Institute. The scientific staff can now settle down to develop the research programme, the basis of which is already laid. As this programme unfolds and is developed along lines of fundamental research both in field and laboratory, it will provide new information leading to improved techniques upon which progress in grassland farming can be made.

The main work of the Institute is concerned with the study of herbage as a crop for feeding to farm animals, and also as a medium for maintaining and improving the crop potential of the soil. Untended grassland is characteristically seasonal in growth, showing a large peak of production in late spring and early summer, followed by a shortage after midsummer and little or no production after September. This marked seasonality in growth is accompanied by equally sharp differences in the quality of the herbage offering to the grazing animal, and this confronts the pastoral farmer with a difficult series of problems in stock husbandry. This is a matter of importance, because grassland in one form or another provides the main basis for the livestock industry as concerns cattle and sheep.

One important field of endeavour, therefore, is to investigate means for providing a more even supply of pasturage not only throughout the normal growing period from April to September but also into the autumn, winter and early spring. Because different

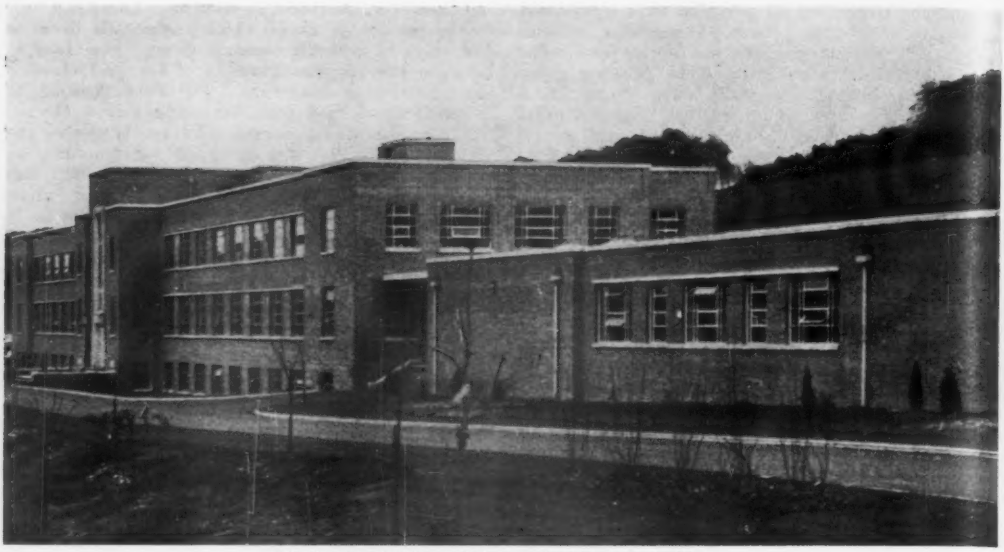


Fig. 1. New buildings of the Grassland Research Institute

species and strains of herbage plants show different growth rhythms, some emphasis is placed on using different seeds mixtures in order to provide for the periods of normally low production. Similarly, the influence of differential fertilizer treatments and of manner of usage of the pasture is being studied with the practical aim of extending the grazing season and of providing a more uniform diet for the grazing animal while at pasture.

The studies of the production and use of the grass crop, however, extend beyond the question of seasonality. The facilities offered by the new laboratories will enable the research staff to follow up the work already commenced in the sphere of animal nutrition and in the evaluation of herbages as livestock feed. Interesting studies on the appetite of animals at pasture are being made and some progress is apparent in the use of methods which will provide a more accurate picture of herbage digestibility as well as of herbage intake. No wholly satisfactory method is yet available which gives a true picture of what the animal eats when at pasture. Indoor feeding and digestibility trials provide only a partial answer and it will, therefore, be an important advance when a reasonably simple series of chemical values can be correlated directly with digestibility and other biological characters of the feed intake. Work along these and associated lines is in progress, and some of this is concerned with the biochemical study of herbage fractions, including both the proteins and the carbohydrates in herbage of different sorts and in various stages of growth.

Detailed studies are being made on growth and development in a number of the grasses, and this work is extended to studies into the physiology of seed production. The ontogeny of the grass shoot (that is, tiller) has been given attention and has led to the interesting suggestion that most tillers are annual or nearly annual. There is a large and very profitable field of work awaiting the attention of the physiologist in the study of both tops and roots of herbage plants subjected to different agricultural treatments. The facilities made available by the new research buildings enable the Institute to investigate a number of problems in this important sphere.

Capital grants for the construction of the laboratories and glasshouses at Hurley have been provided by the Ministry of Agriculture, Fisheries and Food. The main building is in brick with a flat roof. It is pleasing in appearance, due regard having been given to its site in the beautiful countryside of the Thames Valley and Chiltern Hills. The building is of two stories with semi-basement. The latter contains the instrument mechanics' workshop, various stores and several laboratories. It also includes a staff canteen of modern design, and a small staff common room.

The boiler house is at the eastern extremity of the basement. Heating is by oil-burning boilers which, in necessity, could be modified to use solid fuels. The whole building is panel-heated, the panel installation being in floor and ceiling. There are no radiators and therefore no obstructions to laboratory benching on this score. All laboratory equipment is electrical, and since there is no gas supply, all chemical work is also by electric heating, including nitrogen and other determinations. Butane gas cylinders are available for glass-blowing and for other occasional requirements. Demineralized water is serviced to certain of the laboratories, and this has already proved to be most useful. Plastic piping has been used extensively throughout the laboratories, including plastic waste and drainage pipes.

The ground floor houses plant physiology, part of the agronomy units, microbiology, entomology and biometrics. On this floor there are five large laboratories; two of these are for plant physiology, one is for herbage work, another for soil studies and the fifth for microbiology. In addition, there are a number of smaller laboratories and laboratory offices. The main conference room occupies a central position, and above it on the top floor is the Sir George Stapledon Library, which houses the joint Grassland Research Institute/Commonwealth Bureau of Pastures and Field Crops collection of books and periodicals.

The west wing (top floor) is occupied by animal agronomy, animal nutrition and biochemistry. The east wing contains the offices and administrative units of both the Institute and the Commonwealth Bureau of Pastures and Field Crops (Director, A. G. Glendon Hill).

Annexed to the main research block there is a one-story building which is essentially functional in design. This outbuilding contains the cold store (capable of holding 25–30 tons of deep-frozen herbage) with the refrigeration machinery. There is a large herbage weighing room, adjacent to which are grinder and oven rooms; the latter is equipped to house six 'Unitherm' drying ovens used for dry-matter determination on herbage samples. Near the cold store is a spacious metabolism house sufficient to hold twenty-four sheep crates at one time. Alternatively, it will house a dozen or so cattle in individual pens. Already a series of critical digestibility trials has been conducted in the metabolism house, feeding both fresh and frozen plant material to sheep. The outbuilding also contains space for storage, including a store for volatile chemicals, various workshops and arrangements to house technical equipment currently used in the field experiments. There is also shedding for tractors and other vehicles employed in technical work.

To the south of the main building space is reserved for the glasshouse block, and the first glasshouse (subdivided into six units) is already erected. This is heated and is thermostatically controlled. It has been designed primarily for physiological and related agronomic investigation.

The new laboratories at Hurley are well equipped and offer excellent facilities for conducting basic studies on biological materials. There is good laboratory accommodation of functional but simple design and excellent facilities for postgraduate workers, whether of Britain or overseas, to pursue investigations and to train in the important fields of grassland agronomy, animal nutrition, biochemistry of herbage materials, physiology of grassland plants, microbiology, soil problems relating to grassland, and biometrics as applied to grass and animal experiments.

At the opening ceremony, Mr. Heathcoat-Amory spoke of the vital part that the Institute would play in the future of British farming. "Making the most of grass" is the most important single way in which farmers can help themselves and their country. Nearly two-thirds of Britain's 31 million acres of farmland are under grass—but this great asset is under-exploited. Less than one-fifth of our grassland receives regular dressings. Mr. Heathcoat-Amory pointed out that this neglect of grass contrasts sharply with the care devoted to arable crops. The full exploitation of the grass crop would save millions of pounds in the national import bill; for the thousands of small farms, most of which will remain under grass, it offers the greatest hope for the future. The Minister summed up the present position by saying that grass is still taken for granted rather than treated as a crop. Advisory officers are, Mr. Heathcoat-Amory said, devoting more and more attention to the improvement, production and use of grass, and for guidance and news of progress they look to scientific research of the kind the Institute is doing so well. By all reports, the Institute is fulfilling its crucial role. The Minister was particularly impressed by the work being done to extend the grazing season—work of the greatest practical importance. The new laboratories mark, he said, another stage in the Ministry's programme of agricultural research, and proof of the value of this research can be seen in the increasing use made of new techniques and materials in agriculture. British agriculture can only hold its own in a competitive world by the extension and intensification of research —but the funds available for the purpose cannot be increased. Research is useless unless the results are passed on to other research workers and farmers. In this connexion he welcomed the fact that the Commonwealth Bureau of Pastures and Field Crops is housed in the same building as the laboratories.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

REVISED EXPANSION SCHEME

THE architectural plans for new Imperial College buildings on the rectangular site bounded by Queen's Gate, Imperial Institute Road, Exhibition Road and Prince Consort Road were described and illustrated in *Nature* of April 21. The plans, prepared by Messrs. Norman and Dawbarn, provided for the very large new buildings needed for the major expansion being undertaken by the College at the Government's request. Much public attention was focused on one feature of the architectural scheme, namely, the proposed demolition of the Imperial Institute building, designed by Collcutt, the high central tower of which is a well-known feature of the London skyline. The Royal Fine Art Commission expressed the wish that the whole of the Collcutt building should be preserved. The London County Council, as town planning authority, considered the scheme would somewhat overbuild the site, and that a reduction in density might also make it possible to retain at least the tower of the Collcutt building. In consultation with the Royal Fine Art Commission and the London County Council, the College and its architects have now reconsidered the scheme, and have prepared the revised plans announced by the Lord Privy Seal in the House of Commons on June 21.

In the new scheme the Collcutt tower is retained as a free-standing campanile rising from a central court. The whole of the central area of the site has been replanned, and the height of the buildings reduced to avoid conflict between modern rectangular building masses and the tower. Asymmetrically arranged, the central area includes a building for Civil Engineering and one for Electrical Engineering. Behind them will be a Great Hall for about eight hundred, and a low central block containing refectories and common rooms. A high central block placed behind the Electrical Engineering building will contain libraries, administrative offices, common rooms and committee rooms (Fig. 1). The remainder

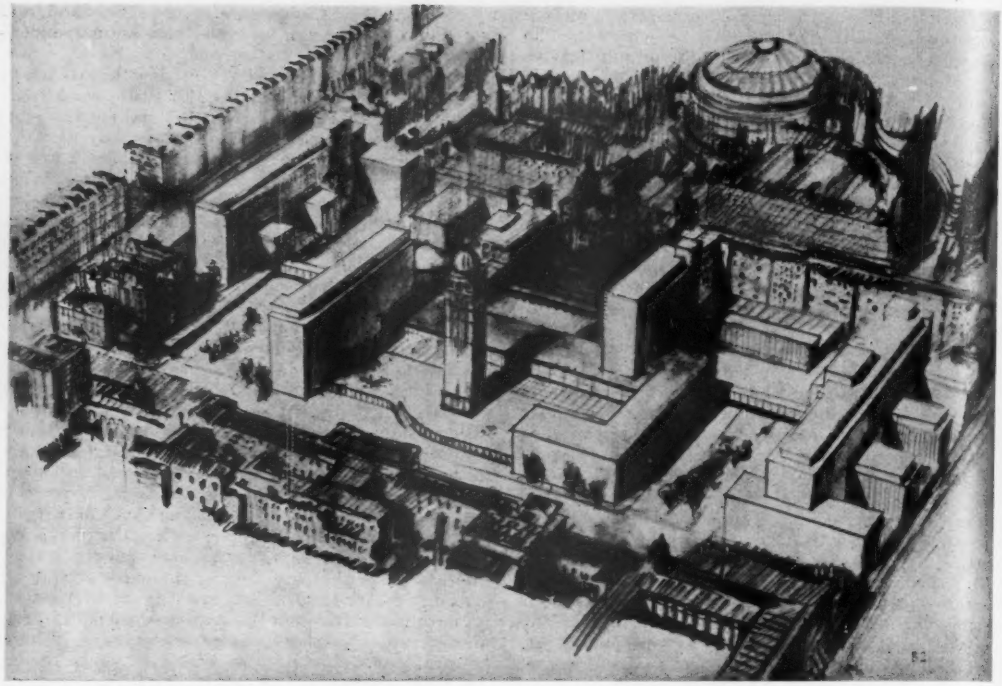


Fig. . Revised scheme, retaining the Collcutt Tower, for the Imperial College of Science and Technology

of the scheme for the main College expansion will be in accordance with the original plans. It has not been found possible to reconcile an expansion on the scale required with the retention of the whole of the Imperial Institute building.

The reduced density of building now proposed for the main site has been made possible by the recent acquisition by the College of the north, east and south sides of Princes Gardens. The Gardens lie just off Exhibition Road, and are about a hundred yards from the College buildings. These sites are reserved for residential purposes, and have been acquired by the College primarily to provide much-needed Halls of Residence for its students. The existing Halls cannot accommodate more than a very small fraction of the growing number of students, and the College hopes to provide 480 new study-bedrooms by the immediate development of the east and south sides of Princes Gardens.

While the Princes Gardens sites are not in any sense a substitute for the central site, the original plans for the central site provided for certain common rooms and refectory facilities which the Planning Authority is prepared to accept in Princes Gardens. Thus a portion of these facilities will now be transferred to the Princes Gardens scheme, where they will occupy half the new building proposed on the south side. The other half of the south side, and the new building proposed for the east side of the Gardens, will be for residence.

NEWS and VIEWS

Oceanography at Gothenburg :

Prof. Hans Pettersson, For.Mem.R.S.

Prof. Hans Pettersson, whose election to the foreign membership of the Royal Society of London was announced recently (*Nature*, **177**, 918; 1956), retired on July 1 from the directorship of the Gothenburg Institute of Oceanography. Pettersson's activities have ranged over a wide field, with particular success in studies of the penetration of light into the sea and of the radium content of abyssal oceanic sediments. A burning desire to probe much deeper into the latter in the interests of geochronology than had earlier been possible led Pettersson during what he called "the enforced inactivity of the Second World War" to promote the construction of, and to test, the implements required. A novel vacuum corer developed in 1942 in association with Kullenberg gave place to the latter's very efficient piston corer, and thereafter the call was for opportunity to use it widely over the great ocean depths. It is Pettersson's crowning achievement that his boundless enthusiasm and persuasiveness produced the large funds which made possible the justly famed Swedish circumnavigation cruise of the *Albatross* during 1947–48, when, as leader, he so effectively fulfilled his "longing to grapple with the mysteries of the ocean floor".

Prof. E. B. Kullenberg

Prof. Einar Börje Kullenberg, who succeeds Prof. Pettersson, was born in Scania, south Sweden, in May 1906, the son of a farmer. Educated at the

University of Lund, where he studied mathematics, physics and chemistry, Kullenberg graduated in 1928. Ten years later he gained his doctorate with a thesis, "Stark Effect of Hydrogenic Fine-Structure". Demonstrator in physics at the University of Lund during 1933–37; on the staff of the Swedish Hydrographic–Biological Commission for a number of years; a staff member of Gothenburg Oceanographical Institute since 1939; a lecturer in oceanography at the University of Gothenburg since 1942; associate professor there since 1948, and a member of the Swedish Board of Fisheries since 1949, Kullenberg has been his country's delegate to the International Council for the Exploration of the Sea since that year. Since 1947 he has been a member of the Academy of Arts and Sciences of Gothenburg, and was, in 1954, elected to the Royal Swedish Academy of Sciences. In 1947 he won the 10,000 Kr. Sixten Heyman Prize, and three years later the Walberg Gold Medal. Kullenberg is the author of publications on the Stark effect, on inertia currents in the sea, on internal waves, the water exchange in estuaries and channels, marine sediments, and the techniques of core sampling in the ocean depths. Widely and rightly famed for his important invention of the piston-corer which has made it possible to take long undistorted sediment cores from great depths, it was upon Kullenberg's calculations of the shapes of long trawl cables that the crowning success of the Danish *Galathea* Expedition in bringing up life from 10,190 m. depended.

Earthquake in the Aegean Sea

A STRONG earthquake with its epicentre near lat. 36° 24′ N., long. 25° 26′ E. occurred on July 9. The epicentre is in the Aegean Sea near the Island of Thira, or Santorin, which has some 15,600 inhabitants. It is reported that more than forty people were killed and several injured as a result of the earthquake, which caused considerable damage, particularly on the western side of the Island. A *tsunami* accompanying the earthquake, and initiated by ground movement on the sea-bed, is reported to have attained a vertical height of 12 ft. and to have travelled as far as Kalymnos, Astipalaia, Andiparus and Iraklion (Crete). The shock was felt in Athens, and was recorded at the Royal Observatory, Edinburgh, at 03h. 17m. 31s. G.M.T. Aftershocks continued for some days after the first earthquake.

The Solar Event of February 23

THE solar outburst that occurred on February 23, 1956, beginning at about 3.32 U.T., was certainly a very remarkable event. A large flare was observed in India (Kodaikanal) and Japan (Mitaka), and the Japanese observers report that the flare was seen in white light as a bright spot near the limb—a very rare observation. World-wide cosmic-ray effects set in within fifteen minutes, and the increase of the intensity of low-energy cosmic rays was greater than any previously reported. The nucleonic flux at sea-level in Britain appears to have increased by a factor of more than 40. Synchronous with the arrival of the cosmic-ray flux, there occurred a disturbance of the lower ionosphere on the night-side of the Earth of a type that does not seem to have been observed before. The reflexion ceiling for very low-frequency waves was lowered and the attenuation increased in a few minutes to beyond the normal day-time values. This effect must be attributed to particles penetrating down at least to the *D*-level, and it is thus to be thought of as connected with the cosmic-ray increase. The data concerning this event that have been obtained in the United Kingdom are published in the May issue of the *Journal of Atmospheric and Terrestrial Physics*.

Reduction of Expenditure in the Department of Scientific and Industrial Research

IN a written answer on July 5 to a question in the House of Commons, the Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, said that the reduction of £150,000 in the published estimate for the Department of Scientific and Industrial Research was made up of £33,000 through slowing up the rate of recruitment of staff; £20,000 through reduced grants for industrial research; a reduction of £49,000 in capital and general expenses of departmental establishments, chiefly through economies in purchases of equipment and consumable stores; and a reduction of £20,000 by delaying the commencement of a new bore-hole for the Geological Survey. Increases in test fees and other similar charges would yield a further £70,000; but against these economies, expenditure on scientific grants was increased by £42,000, of which £37,000 was for nuclear physics.

Mathematics in Industry

IN the *American Mathematical Monthly* of February, Thornton C. Fry, of the Bell Telephone Company, writes on "Mathematics as a Profession Today in Industry". To-day we educate to-morrow's mathematicians, and our curriculum should be adapted to to-morrow's needs; we cannot forecast these needs in detail, but by extrapolation from what has happened during the past fifty years, we may be able to foresee general lines of development. We shall make new things, standards of precision will be more stringent, and over-all planning for a total situation will be at least as important as concentration on accuracy in functional components. Such tasks demand collective knowledge and the exploitation of collective knowledge demands collective action. The requisite breadth and depth of technical competence can be supplied only by a team of experts, fully equipped and co-ordinated. What is the proper place of the mathematician in such a team? He should not be there as a problem solver; that is not his job, but the job of a machine. He should be there to formulate problems, to analyse relations, to strip off the superficial flesh and lay bare the essential structure. Fry illustrates this by reference to the central position occupied by mathematicians in the 'Nike' project, and draws the inference that industry requires mathematicians of the highest class to serve as superior consultants in planning operations; they are not to be called in merely to solve petty problems. To train such mathematicians, teachers must first understand the requirements; secondly, they must economize in time, so that training does not consume the fruitful years of the young mathematician. Fry suggests that algebra might be taught along with or even before arithmetic, that calculus and complex variable could be introduced in the ninth school-year, and that this could be done without any increase in the time allotted to mathematics in the schools. He admits that this is not an easy programme; many teachers in Britain favour the early introduction of calculus, but few would advocate any serious study of algebra before a firm grasp of arithmetic had been ensured.

The Need for Capital Investment in British Industry

In an article on "The Capital Question", in the May issue of the *Westminster Bank Review*, Mr. Graham Hutton stresses the need for more industrial capital in Great Britain; he argues that a substantial expansion of savings is needed, a severe reduction in 'investment' in public apparatus to provide consumers' services or durable goods, and a large increase in real investment in productive equipment and services, whether State or privately owned. Governments, he continues, have not looked carefully enough at the amounts and kinds of capital needed by Britain in its post-war situation, in which the population over the age of sixty is increasing faster than in any other industrialized nation, the birth-rate steadily falling, the money-income level rising annually faster than output and productivity, and in which the highest personal taxation on higher earnings in the Western world and the fastest inflation have redistributed incomes in favour of mass consumption rather than mass saving, so that there has been too little net personal saving in the decade. During the seven years 1948–56, capital formation for transport and communications represented nearly 12 per cent of the total, but contributed only 8 per cent to national output, and capital has not yet begun to be spent for more than maintenance (if that) of roads and railways. Manufacturing industry, providing 94 per cent of exports and nearly 40 per cent of output, only received 25 per cent of gross capital and had its capital programmes cut in each of the four post-war economic crises. On an average over the seven years, public enterprises received broadly two-thirds of all capital formation, and private enterprise, which provides all the exports and 75–80 per cent of output, only one-third, if that. Moreover, since 1948 the crude index of output against employment in manufacturing has risen 9 per cent more in France than in Britain, and 100 per cent more in West Germany and Japan, and Mr. Graham Hutton asserts that more hours a week or year are actually worked in Britain than in any of these countries. On an average, for British male adults a full working day in industry is longer than that for industrial workers in the United States, and the material return roughly one-half the American worker's real earnings.

Muelleria: a New Herbarium Journal

As Mr. A. W. Jessep, the director and government botanist at the Melbourne Botanic Gardens and National Herbarium, has pointed out, the National Herbarium of Victoria is the oldest and most extensive repository of Australasian herbarium material. It contains approximately one and a half million numbers of botanical specimens—evidence of the floristic richness of this great region. The adjacent Melbourne Botanic Gardens also support very rich and important collections. A new journal, *Muelleria* (1, No. 1 (August 1955); published by the Botanic Gardens and National Herbarium, Melbourne), which is named after the first government botanist of Victoria, F. J. H. Mueller—a man of great distinction whose work began a century ago—is intended primarily as a medium for the publication of botanical monographs, descriptions of new species and taxonomic studies generally, horticultural papers, and other botanical matters of general interest to professional and amateur botanists. In short, as the sub-title indicates, it will be an *Australian Journal of Botany*. As Prof. J. S. Turner rightly points out in a foreword, systematic botany is important, and, indeed, occupies a fundamental place, in contemporary research in agriculture, horticulture and forestry. The journal is edited by Mr. J. H. Williams, and the first issue contains notes and descriptions of a variety of new species of flowering plants and of cryptogams, and historical and bibliographical matter.

Journal of the Textile Machinery Society of Japan

The Textile Machinery Society of Japan is an organization formed for the purpose of advancing knowledge and technique in textile processing. It is a professional organization apparently similar in general structure to the Textile Institute in Britain. The Society publishes a monthly *Journal* in Japanese and, in 1955, decided to publish an English edition containing translations of articles which are considered to be of international interest. Judging from the first two issues (1, Nos. 1 and 2 (March and November 1955); from the Society at 28, 2-Bancho, Namba Shinchi, Minami-ku, Osaka; 10*s*. per copy), the scope of the new *Journal* appears to be wide, covering all the textile fibres, and all stages of textile processing. The papers cover general topics, articles on textile machines and scientific research. The technological and scientific papers are of a standard similar to those published by the Textile Institute. The Society also arranges public lectures, seminars and visits, and it is proposed to publish reports on some of these activities in future issues of the English edition. Each number contains about seventy pages, of quarto size, with good printing and diagrams and very readable English translations of the original papers. They also contain some seventy pages of Japanese textile advertisements, but these are kept at the back of the publication and do not impair the reading of the papers.

Nutritive Aspects of Preserved Food

International conferences can be very stimulating affairs for those who attend, and the discussions, in particular, often open up entirely new lines of thought. Publication of the proceedings can extend the stimulus to a much wider circle of workers, but only if publication follows close on the heels of the conference itself. All too often there is a delay of a year or more, by which time the material in the papers themselves has staled, and suggestions for further lines of inquiry have already been followed up. The proceedings of the symposium on nutritive aspects of preserved food, held in the Swedish Institute for Food Preservation Research, Gothenburg, during October 1954 (pp. 173; Publication No. 115 of S.I.K., Göteborg, 1956; 30 kr.), have been published approximately eighteen months after the conference took place; despite this delay, many of the papers are still badly in need of editing, the English sometimes being so poor that a sentence must be read several times over before the meaning can be grasped. The papers dealt with various aspects of nutrition and food technology and were presented by delegates from half-a-dozen different countries; they range from well-documented scientific studies to uncritical generalities put forward with insufficient and unsubstantiated evidence. The main use of the publication now lies in the review articles by Prof. G. Borgström (nutrition and food technology), Prof. R. A. Gortner (recent progress in the

field of nutrition) and Prof. A. C. Frazer (the control of the use of chemical aids in food processing), and the evidence provided by the other papers about different lines of work being followed by different countries in 1954.

Bird Collection at Birmingham Museum and Art Gallery

THE collection of British nesting birds in the Natural History Department of Birmingham Museum and Art Gallery commemorates in part the eminent public services of the late Alderman C. G. Beale, first vice-chancellor of the University and four times Lord Mayor of Birmingham. Funds provided by public subscription enabled work to be started in April 1913, and in May 1920 the memorial, encompassing forty-two nesting groups of common British species, was complete. Wherever possible, each nesting site was removed bodily from its surroundings, carefully preserved and reassembled for display. Every effort was made to secure the original parent birds, their eggs and their young. In the few instances where modelling became necessary, the original surroundings were photographed, measured, described and accurately reproduced. The greatest possible care was constantly taken by the taxidermists to give a faithful presentation of the various nesting groups, so that the collection is now rightly regarded as one of the best of its kind. A booklet describing the collection has been issued by the Museum (price 2*s*.), and photographic postcards of most of the groups in the collection are also available (price 4*d*. each).

Tracer Techniques in the Study of Host–Parasite Relationships

THE accumulation of radioactive substances at loci of infection of some facultative and obligate fungal parasites and of tobacco mosaic virus has been investigated by M. Shaw and D. J. Samborski (*Canad. J. Bot.*, **34**, 3, 389; 1956). Excised, parasitized leaves were placed with their bases in radioactive solutions or exposed to radioactive carbon dioxide, and the uptake and distribution of the tracers followed by autoradiography. Carbon dioxide and twenty other carbon compounds, including sugars, amino- and organic acids, phenols, and indoleacetic acid, and/or their metabolic products, as well as phosphate and calcium, accumulated strongly at uredial and conidial loci of the obligate parasites *Puccinia* and *Erysiphe* respectively. An accumulation of glucose, which occurred in the host tissue at the sites of mildew colonies on leaves from which the ectoparasitic fungal mycelium had been removed, ran parallel with the respiration-rate and increased progressively with the development of the parasites. It was inhibited by sulphur dust (with mildew), sodium azide, 2,4-dinitrophenol and, reversibly, by anaerobiosis, and was therefore dependent on aerobic respiration. On the other hand, the tracers did not accumulate within senescent rust and mildew colonies or within the necrotic lesions produced by bacterial and fungal parasites which kill the tissues of their hosts. Radioactive glucose did not, but calcium and phosphate did, accumulate within young local lesions of tobacco mosaic virus on *Nicotiana*. The tracers did not enter dead areas on mechanically wounded leaves, and only accumulated at fresh wounds under conditions conducive to a high rate of water-loss from the damaged surface.

The Soul in a Primitive Society

IN his Fraser Lecture for 1955, given under the title "The Fate of the Soul" (Cambridge: At the University Press, 1955; 2*s*. 6*d*.), Prof. Raymond Firth returns to a subject examined by Sir James Fraser in his "Belief in Immortality and the Worship of the Dead". Firth's approach is, however, functional and not ethnological, as was Fraser's. His interest lies in these beliefs in terms of their social functions and, in support of his argument, he examines the eschatological beliefs of a particular society, Tikopia, relating them to its social structure and organization, with particular reference to the changing religious system. His conclusion is that the framework of ideas about the fate of the soul is in many respects a framework of ideas about the state of society, and that they are concerned primarily with emphasizing the continuity of society rather than the continuity of the individual personality.

Standard X-ray Diffraction Powder Patterns

THE fifth in the series of "Standard X-ray Diffraction Powder Patterns", prepared by the National Bureau of Standards, Washington, D.C., has recently been published as Circular No. 539 of the Bureau (pp. 75. Washington, D.C.: Government Printing Office, 1955. 45 cents). In it, forty-five standard X-ray diffraction patterns are presented relating to two elements and forty-three inorganic compounds. The patterns are recommended to replace seventy-four cards in the card file of the American Society for Testing Materials, and, in addition, five compounds (cæsium chloroplatinate, cæsium chlorostannate, germanium iodide, rubidium chloroplatinate and thallium chloroplatinate), which are not represented in the file, are included. The experimental procedure used for obtaining the patterns and the general plan of the reports are the same as those in the volumes previous to Circular 539. The patterns are of use in many applications, but primarily for the identification of unknown crystalline materials. The samples used were of exceptionally high purity, and the patterns were made with a Geiger-counter X-ray diffractometer. The new publication concludes with a cumulative index to Vols. 1–5; but it is emphasized that further work on the programme is in progress, and it is anticipated that additional volumes in the series will be issued.

Professional Engineers Appointments Bureau: Report for 1955

THE report for 1955 of the Professional Engineers Appointments Bureau (9 Victoria Street, London, S.W.1) shows that there was no significant change in the numbers of civil, mechanical and electrical engineers registering with the Bureau, but the number of vacancies notified increased by 20 per cent. The total placings rose by 15 per cent above the figure for last year, but the more rigid specification of requirements laid down both by those registered and by prospective employers tended to reduce the field of selection. More of the placings were for senior appointments and fewer for junior posts. More employers and engineers approach the Bureau informally to discuss their problems and to review the general employment market. In general, firms which are rapidly expanding are having great difficulty in securing staff who have the particular specialized experience that is now required in many posts in industry.

Directory of British Insecticides, Fungicides and Weedkillers

The Association of British Insecticide Manufacturers has recently published the third edition (1956) of its "Directory" of British insecticides, fungicides and weedkillers (pp. 128; from the Association, London, 1956). In addition to a directory of member firms of the Association, the publication provides information on the chemicals available for the control of insects, fungi and weeds, and where they may be obtained. Proprietary and trade names are also given, with an indication of the use of each proprietary product. Information is also given on where to obtain accessory materials such as wetters, spreaders and stickers and the machines for applying the chemicals. The Directory should prove most useful to all those interested in the supply and use of chemicals for pest control. It is fully indexed.

Library of the University of Leeds: Report for 1954–55

The annual report of the librarian of the University of Leeds for the session 1954–55 (pp. 12; from the Brotherton Library, Leeds) records holdings on June 30, 1955, of 389,118 volumes and 163,866 pamphlets. Of these, 279,625 volumes and 110,988 pamphlets are in the Brotherton Library, the corresponding figures for the Medical Library being 28,209 and 3,645, respectively; for the Agricultural Library, 9,457 and 25,980; and for the Textile Library, 5,225 and 900. Accessions for the year totalled 9,859 volumes, 2,355 pamphlets and 25,762 periodical parts, a decrease of 7 per cent. Loans to readers totalled 94,531, an increase of 4 per cent, and inter-library loans totalled 4,218, the books borrowed increasing by 22 per cent to 1,510 and those lent by 2 per cent to 2,708. Detailed consideration was given during the year to regulations for the consultation and loan of theses, and there was no difficulty in accepting the general desirability of making available the work contained in theses of the University. Subject to the desire to protect the author and obviate premature publication prejudicial both to the author himself and the department concerned, every effort will be made to facilitate the proper use of thesis material by qualified readers both in the University and outside it. The Council of the University has also generally approved the proposal that graduate members of the library staff should, in suitable circumstances, be given periods of up to three months of leave for research. Staff changes have been largely responsible for a 34 per cent fall in the cataloguing output, but the insistent demands of the reading room and the need of assistance in the sectional libraries have also contributed to this.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: W. H. Edwards (agricultural officer, Uganda), assistant director of agriculture (field), Uganda; A. M. M. Rees (agricultural economist, Northern Rhodesia), agricultural economist, Jamaica; T. A. A. Talbot (assistant agricultural officer, Kenya), agricultural officer, Kenya; J. D. Yelf (agricultural officer, Northern Rhodesia), senior agricultural officer, Fiji; P. F. Burgess (assistant conservator of forests, Federation of Malaya), senior assistant conservator of forests, North Borneo; F. G. Harper (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; Dr. J. R. Audy (medical officer, Institute for Medical Research, Kuala Lumpur, Federation of Malaya), specialist (grade B), senior virus research officer (superscale H), Federation of Malaya; E. F. Duck (government pathologist, Hong Kong), pathologist, General Hospital, Bahamas; M. P. Hutchinson (research epidemiologist, West African Institute for Trypanosomiasis Research), deputy director, West African Institute for Trypanosomiasis Research); Miss V. Suter (scientific officer, Colonial Microbiological Research Unit, Trinidad), senior scientific officer, Colonial Microbiological Research Unit, Trinidad; P. T. Walker (scientific officer, Colonial Insecticides Research Unit, Tanganyika), senior scientific officer, Colonial Insecticides Research Unit, Tanganyika; A. E. Dorman (provincial veterinary officer, Kenya), assistant director of veterinary services, Kenya; K. J. R. Maclennan (senior veterinary officer, Northern Region, Nigeria), principal veterinary officer, Northern Region, Nigeria; W. Plowright (veterinary research officer, Federation of Nigeria), veterinary research officer (pathologist), East African Veterinary Research Organization, East Africa High Commission; A. J. Bearman (principal, School of Pharmacy, Federation of Nigeria), chief pharmacist, Federation of Nigeria; E. Cundiff, agricultural officer, British Guiana; C. L. M. van Eynatten, scientific officer, plant breeder, Maize Rust Research Unit, Federation of Nigeria; K. Paijmans, assistant conservator of forests, Gold Coast; M. J. Fleuty, geologist, Uganda; J. D. Arneaud, pathologist (grade A), Trinidad; A. T. Brough, statistician, East Africa High Commission; G. D. Phillips, veterinary research officer, East Africa High Commission.

Announcements

Dr. T. K. Walker, reader in fermentation processes in the Faculty of Technology, University of Manchester, has been given the status of professor, with the title of professor of industrial biochemistry, in the University.

In the article entitled "Tube Investments Research Laboratories" in *Nature* of July 14, p. 60, it should have been stated that the cobalt irradiation equipment was designed and built by Nuclear Engineering, Ltd., of Greenwich Metal Works, London, S.E.7.

Tubercle, the journal of the British Tuberculosis Association, has, since the beginning of this year, appeared two-monthly in an enlarged size, with an improved format. In addition to tuberculosis, the journal deals with respiratory disease in general and related infections, for example, leprosy; laboratory as well as clinical and epidemiological aspects are included. Dr. J. R. Bignall has recently been made editor and a new Editorial Committee appointed.

In 1955, the Muséum d'Histoire Naturelle, Paris, set up an exhibition to direct attention to the importance of safeguarding natural resources and to illustrate the damage done to animal and plant life and to the soil itself. The nucleus of this exhibition is now being sent to a number of different countries. In Britain, under arrangements made by the Society of the Men of the Trees, it is being shown in the Senate House of the University of Cambridge during July 18–31; and it is hoped that it will be shown afterwards in London.

Erratum. In the communication entitled "Origin of the Common Wild Oat, *Avena fatua* L.", by D. J. Griffiths and T. D. Johnston (*Nature*, July 14, p. 99), Fig. 1 has been inadvertently printed upside-down.

A NUMERICAL CALCULATION OF THE GENERAL CIRCULATION OF THE ATMOSPHERE

MUCH work has been done in recent years in the calculation of changes in the wind and temperature of the atmosphere from hydrodynamic and thermodynamic theory. The equations are non-linear partial differential ones and, moreover, the atmosphere is a turbulent fluid of variable viscosity, subject to heating and cooling by radiation and changes of state of water and retarded at the ground by surface friction. It is now well realized that only by applying dynamical theory to the atmosphere can serious progress be made, and the method is the classical scientific one of studying simplified model atmospheres and comparing the results with observations.

Hitherto, the models used have not allowed for friction or for heating and cooling by radiation. In such models, temperature changes adiabatically only in association with pressure. Now, however, in a paper in the April number of the *Quarterly Journal of the Royal Meteorological Society*, which has since been awarded the first Napier Shaw Memorial Prize, N. A. Phillips, of the Institute of Advanced Study, Princeton, describes an experiment in the numerical calculation of atmospheric changes allowing for friction and non-adiabatic heating. Phillips starts with an atmosphere at rest relative to the Earth and at a uniform temperature, and calculates developments. The calculation is based on approximate equations of motion and thermodynamic energy-change. The upper atmosphere is represented by the 250-mb. level and the lower by the 750-mb. one. The surface of the Earth and its associated friction and zero vertical velocity is everywhere at 1,000 mb. The divergence at the 750-mb. level is necessarily equal and opposite in sign to that at 250 mb. Important assumptions are: hydrostatic equilibrium in the vertical; geostrophic wind except in one term of the equations; constancy of the Coriolis parameter and its derivative with respect to latitude; and constancy with height of the stability parameter $(\theta_1-\theta_3)/\theta_2$, where θ_1, θ_2, θ_3 are potential temperatures at 250, 500 and 750 mb.

The atmosphere is supposed to be heated by radiation from the equator to latitude 45° and cooled from there to the pole at a rate independent of height but proportional to distance from latitude 45°. Friction at the ground and lateral and vertical diffusion are allowed for with reasonable assumptions. Empirical mean values are used for the various constants. The equations of motion and energy are reduced to finite difference form and solved on an electronic computer for values at a grid of points at intervals of 625 km. latitudinally and 375 km. longitudinally.

Calculations were made over a rectangular area of width 6,000 km. from west to east and depth 10,000 km. from south to north. The boundary conditions were: (*a*) identity of values of all elements at a given latitude on the east and west boundaries; (*b*) zero normal geostrophic wind and zero disturbed geostrophic vorticity on the south and north boundaries.

Starting from the state of rest and uniform temperature and with the restraint that the flow was independent of longitude, the flow and temperature patterns were first computed step by step for a period of 130 days, by the end of which time there were a nearly uniform fall of temperature from equator to pole, broad westerly winds with the reasonable maximum of 36·3 m./sec. in middle latitudes at 250 mb., a weak easterly wind (order 1 m./sec.) at the surface and a minute southerly wind at 250 mb. On this circulation there was then superimposed a small random flow initially independent of height but varying horizontally in a random manner, and the development again computed. This culminated in the formation of a large central depression moving eastward at about 1,800 km./day and having features, such as isobars like those at fronts, corresponding to real depressions and with a marked westerly jet-stream and a mean poleward flux of energy.

Considering the assumptions made, the result must be regarded as a remarkably close approximation to reality, and the paper is one to be read by all meteorologists and mathematicians interested in that most difficult problem of hydrodynamics, the circulation of the atmosphere.

INDUSTRIAL APPLICATIONS OF THE ELECTRON MICROSCOPE

A CONFERENCE on "Industrial Applications of the Electron Microscope", organized by l'Association des Ingénieurs sortis de l'École de Liège, was held in Liège during May 2–5. Representatives of fourteen countries were present. The main part of the conference was devoted to the study of metals and one session to chemical problems. Throughout the conference it was noteworthy that, although applications of the electron microscope were described in all papers, in few was the microscope given undue prominence. It appears that the electron microscope is now being used as just one more piece of apparatus in the laboratory. The results obtained are valuable and, in many cases, not obtainable in any other way; but the time has passed when problems are being sought specifically to find a use for the electron microscope.

Dr. L. Habraken (Centre National de Recherches Métallurgiques, Liège) welcomed the visitors on behalf of the Association and of the C.N.R.M. and introduced the first speaker, Dr. J. B. Le Poole (Technisch Hoogeschool, Delft), who traced the history and probable future of electron microscopes. Early electron microscopes were merely optical analogues of light microscopes; the resolution obtainable to-day had only been achieved when methods of lens correction specifically applicable to electrons and not to light had been applied. New methods in the optics of charged particles, in particular, devices using velocity

selection, made it possible to go further and use the electron microscope as a direct means of chemical analysis of the specimen. Prof. C. Fert (University of Toulouse) described the present state of his researches on the direct examination of metallic surfaces by the reflexion electron microscope. Resolution of 300 A. is now obtained and the distortion of the image resulting from the small angle of viewing has been eliminated, partly by viewing at larger angles, partly by the use of cylindrical lenses to equalize the magnification in directions parallel to and perpendicular to the beam. A paper from Prof. G. Mollenstedt (University of Tübingen) and read by Dr. H. Mahl described a new form of microscope which depends on focusing electrons released from metallic specimens by ionic bombardment. Using it, bulk metallic specimens can be examined with a resolution of 500 A. The theoretical limit of resolution is 100 A., and specimens can be examined at any temperature, for example, during the course of phase transformations.

One session was devoted to new techniques in metallography. There were no papers describing yet more replica techniques. Instead, all contributors dealt with methods of making use of the full resolving power of the electron microscope instead of the many times inferior resolving power of replicas. The highest resolving power (10 A.) was claimed by Prof. R. Castaing (University of Toulouse) for his thin-specimen techniques. Metal foils are first etched, then bombarded cathodically until they are thin enough to transmit electrons. Using specimens prepared thus, it has been possible to study the early stages of precipitation in aluminium–4 per cent copper alloys, including observations of the formation of Guinier–Preston zones. Thin films had also been studied by Dr. K. Ito (Electron Optical Laboratory, Tokyo), who had prepared his metal films by evaporation. The Japanese workers had constructed small furnaces and cryostats in which these films could be heated and cooled while actually under observation in the electron microscope. The stages in the precipitation of the various intermetallic phases from a 50–50 aluminium–copper alloy had been followed at high temperatures, and the crystallization of mercury had been observed at −180° C. Mme. Stoyanova (Electron Microscopy Laboratory of the Electronics Industry, Moscow) described how electron microscopy under dark-field conditions made possible the chemical identification of sub-microscopic and even sub-electron microscopic particles. In conjunction with the thin-film methods of Castaing and Ito, these dark-field techniques give most powerful methods of investigating the earliest stages of segregation of foreign atoms in metallic solid solution. Two papers from the Technical High School, Aachen, were devoted to the location and identification of fine precipitates in steels. In a new process described by Dr. H. Goosens, the specimen is etched until the precipitates stand out from the surface. A plastic film is then cast on the surface in order to hold the precipitates in position and finally the rest of the metal is etched away. By this means the actual precipitates can be examined free from the matrix but in their correct relative positions and at the highest resolution available in the electron microscope. Their chemical nature can likewise be determined by X-ray or electron diffraction. An application of this method to the study of grain-boundary inclusions was reported by Dr. H. K. Gorlich of the same laboratory, while a third paper describing the use of a similar technique was delivered by Dr. A. Schrader (Max Planck Institute, Düsseldorf), who had examined extremely fine precipitates in chromium–nickel–molybdenum steels, and followed the changes produced in them during creep.

Several invited papers reviewed the current position in the study of the relationship of microstructure to mechanical properties: Dr. J. Nutting (Metallurgical Laboratory, University of Cambridge), dealing with ferrous materials, showed that it was now possible to predict the creep properties of steels quickly by means of the electron microscope and without the necessity for lengthy creep tests at high temperatures. Creep resistance has been found to require the presence of highly refractory, very small (about 20 A.) particles highly dispersed in the matrix. Dr. A. Saulnier (Société Pechiney, Chambéry) explained how the strength of non-ferrous alloys were derived from the clustering of solute atoms into metastable aggregates with dimensions often less than 1/10 μ. In the aluminium alloys containing copper or magnesium, and also in various titanium alloys, these aggregates had been detected and identified by the electron microscope. Similar work in relation to the complex gas-turbine alloys containing nickel, copper, aluminium and titanium was reported by Dr. Y. Baillie (Office National d'Études et de Recherches Aéronautiques, Paris). Plastic deformation of pure metals was reviewed by Dr. A. F. Brown (University of Edinburgh). Present evidence obtained from electron microscope observations of the surface of pure metals conflicted with the results of other experiments, such as electrical resistance measurements, which aimed at studying the properties of the bulk of the material. Thus, experiments required to be devised by which the effects of plastic deformation could be detected under the surface of the metal. One such method based on the use of radioactive tracers was further developed in a paper by Prof. N. Feather, Dr. D. J. Shapland and Dr. A. F. Brown (University of Edinburgh), which described an electron optical method of improving the resolution of autoradiography.

A study of fracture surfaces had been systematically carried out by J. Plateau, G. Henry and Prof. C. Crussard (Institut de Recherches de la Sidérurgie, St. Germain-en-Laye), who presented micrographs showing the fine structure of brittle, ductile, intergranular and fatigue fracture surfaces. In ductile fracture it has sometimes been possible to trace the origin of the fracture to submicroscopic inclusions. Etching techniques of great delicacy had been employed by Dr. Wan Wijk (Metaalinstitut, Delft) to reveal the distribution of dislocations in pure iron and mild steel. It appears that the Cottrell atmospheres which surround the dislocation lines are either more or less susceptible to chemical attack than the surrounding matrix, depending on the nature of the impurities and the etchants. The surface of the metal is thus seen to be covered with a system of about 10^{10} tiny pits or mounds per cm.^{2}, giving the well-known 'orange peel' appearance usually observed after electrolytic polishing.

A complete session was devoted to the uses of the electron microscope in the chemical industry. The chief speaker was Dr. H. Mahl (Zeiss, Oberkochen), who reviewed the methods available and the results achieved in industrial quality control. Dr. J. J. Fripiat (University of Louvain) described how the electron microscope was assisting conventional techniques of soil analysis. Other notable contributions to the conference included a brief description by Prof. G. M. Kushnir (Electron Microscopy Laboratory of

the Electronics Industry, Moscow) of the various electron microscopes and electron diffractographs manufactured in the U.S.S.R. All types are available, including electrostatic instruments and reflexion instruments, the best resolution commercially available being about 20 A. There are about 350 electron microscopes in use. From the United States, Dr. W. L. Grube (General Motors Corporation, Detroit) summarized the work of the committee of the American Society for Testing Materials, which is investigating the electron microstructure of steel. It is intended to collect complete metallographic evidence of the structure of steels as seen in the electron microscope at highest resolving power, and thus to encourage the use of the results in steel works laboratories for ordinary quality control.

The final session included a visit to the laboratories of the Centre National de Recherches Metallurgiques. These richly equipped laboratories have been built since 1945 on the site and using the external architecture of an old abbey. They have already made notable contributions to metallurgy, particularly to the knowledge of steels. A. F. BROWN

HYPOTENSIVE DRUGS AND THE CONTROL OF VASCULAR TONE IN HYPERTENSION

UNDER the auspices of the Co-ordinating Committee for Symposia on Drug Action, a symposium on hypotensive drugs and the control of vascular tone in hypertension was held at the Wellcome Building, London, N.W.1, during April 5 and 6. The meeting was organized by a committee representing the British Pharmacological Society, the Physiological Society, the Section of Experimental Medicine and Therapeutics of the Royal Society of Medicine, the Fine Chemicals Group of the Society of Chemical Industry, the Biochemical Society, the Pharmaceutical Society, the Association of Anæsthetists and the Society for Endocrinology.

The conference was opened by Sir Charles Harington, chairman of the Co-ordinating Committee for Symposia on Drug Action, who briefly reviewed the function of the Committee in organizing symposia on subjects which are of interest to several different societies. He expressed appreciation of the generous hospitality of the Wellcome Foundation, Ltd., the contributions of which to knowledge of the subject extend over many years. He felt particular pleasure in opening the symposium because of the work of the late Dr. Harold King at the National Institute for Medical Research on the development of the methonium compounds and on the elucidation of the chemical structure of D-tubocurarine. After referring to the work of Dr. H. R. Ing, Dr. Zaimis and others, he invited Prof. F. Bergel to take the chair at the session on "Chemical and Biochemical Aspects".

The first speaker was Dr. H. R. Ing (Oxford), who discussed "Structure-action Relationships of Hypotensive Drugs". Of the veratrum alkaloids, the most potent are the ester-alkaloids, which retard the heart-rate and respiration by interference with the afferent nerve endings in the lungs. The vasodilator amidines behave similarly and, of these, phenyldiguanide, its *o*-chloro derivative, and 2-α-naphthylethyl*iso*thiourea are especially potent. Compounds of similar type which have found clinical application are tolazoline, hydralazine (1-hydrazinophthalazine), and phentolamine, all of which produce rapid but transient competitive inhibition of the actions of adrenaline and noradrenaline.

Dibenamine (N-[2-chloroethyl]diphenylamine) exhibits a non-competitive inhibition. The onset of activity is slow and, though the blockade can be overcome in the early stages, its action becomes permanent. It is suggested that initial adsorption at an active centre, possibly involving intramolecular alkylation, is followed by reaction of the ethyleneimmonium ion with groups such as —SH, —OH, or —NH_2.

The *Rauwolfia* alkaloids, for example, reserpine, deserpidine and reserpinine, also show a slow onset of action. Little is known of their structure–action relationships.

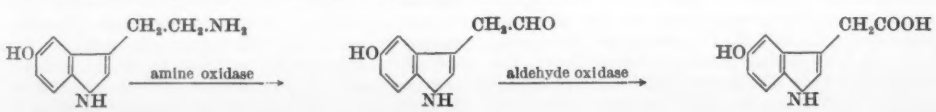
Ganglionic stimulating and blocking activity is shown by a considerable number of secondary, tertiary and quaternary bases. Several quaternary trimethylammonium bases exhibit stimulatory activity, while their triethyl analogues are inhibitors. The *bis*-quaternary ammonium bases, such as hexamethonium and pentolinium, have a purely blocking action. The end-groups vary in potency with differences in chain-length. $Me_2Et\overset{+}{N}.CH_2.CH_2.OCH_2.CH_2\overset{+}{N}Et_2$ is more effective as a blocking agent than corresponding symmetrical compounds. The blocking agents are frequently of value in hypertension when administered parenterally. It is probable that the quaternary bases will eventually be supplanted by tertiary or *bis*-tertiary compounds, which are usually better absorbed from the alimentary canal. These are frequently stimulatory in small doses, but inhibitory in larger amounts.

Dr. H Blaschko (Oxford) then presented a paper entitled "Biochemical Principles in relation to Hypotensive Drug Action". After explaining that the effectiveness of a given compound is governed by its concentration in the neighbourhood of the receptor centre, the biosynthetic route to adrenaline was traced. The metabolic pathway appears to be as follows:

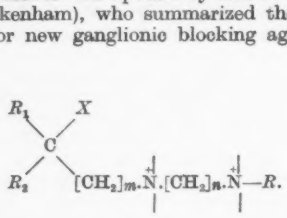
Tyrosine → 3 : 4-dihydroxyphenylalanine (DOPA) → 'Dopamine' → noradrenaline → adrenaline.

It has been established that chromaffin tissue is rich in DOPA decarboxylase, which controls the second stage of this route, and also that in various systems about 6 per cent of 'Dopamine' can be converted into noradrenaline. Inhibitors of DOPA decarboxylase have been investigated, but it seems that studies of 'Dopamine' dehydrogenase might offer a more hopeful approach.

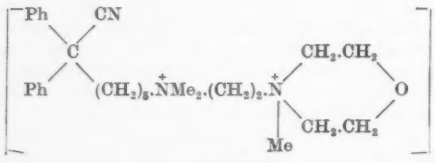
Reserpine has been shown to stimulate the release of 5-hydroxytryptamine (serotonin) from mitochondria. This substance then undergoes degradation to 5-hydroxyindoleacetic acid, which is excreted in the urine:



The discussion was opened by Mr. J. W. Billinghurst (Beckenham), who summarized the results of a search for new ganglionic blocking agents in the series :



As the value of m is increased to a maximum of 6, the duration of the effect (mydriasis in mice) is prolonged. One of the most interesting compounds from the clinical point of view is :



(365*C*54)

Prof. H. McIlwain (London) pointed out that the diversities of action of the compounds mentioned during the session are a hopeful sign, and illustrated his point by reference to the many effects of protoveratrine. In reply to Dr. H. J. Barber, who asked if the nature of the anion has any effect on the activity of the ganglionic blocking agent, Dr. M. Harington said that the anion appears to influence only the rate of absorption of the drug.

The second session was devoted to "The Pharmacology of Hypotensive Drugs", under the chairmanship of Prof. J. H. Burn. The first paper was by Dr. J. Tripod (Basle) on "Some Pharmacological Differences between Hypotensive Drugs, with special reference to Hydralazine and Reserpine". He discussed the differentiation of hypotensive drugs according to their specific antagonisms of a variety of vasoconstrictor agents. The fall in blood pressure produced by hydralazine is abolished by previous incubation with rabbit serum. Veratrine and reserpine, on the other hand, are not affected by such treatment.

During discussion it was stated that the inactivation of hydralazine is not due to hydrazone formation. While protein hydrolysates cause inhibition, no amino-acids are found to produce this effect.

Dr. Marthe Vogt (Edinburgh) then discussed "Theories concerning the Site and Mode of Action of Reserpine". The central effects of reserpine, for example, sedation, are mediated through the hypothalamus, but this is not the only site of action. After 1·5–2 mgm./kgm. in rabbits, the encephalogram shows the disappearance of the high-voltage slow waves which are normally seen in sleep or after barbiturates. The effect is different from that of barbiturates, for the animals can be roused. The chief peripheral effect is flushing, that is, dilatation of the capillaries, which is independent of the central nervous system.

The long latent period of action ($\frac{1}{2}$–1 hr.) implies that some metabolite is responsible for the effects of reserpine, but no products of hydrolysis have been shown to have any pharmacological action. It has been suggested that it causes release of 5-hydroxytryptamine (5-HT) from body stores; thus the urinary output of 5-hydroxyindoleacetic acid is increased, and the 5-HT stores in the argentaffin cells, the brain and the platelets are diminished after the administration of reserpine. Furthermore, 5-HT prolongs barbiturate-induced sleep in mice, and all known *Rauwolfia* alkaloids showing a central effect affect the release of 5-HT. Thus, it would appear that depletion of the 5-HT stores is responsible for the effects of reserpine; but this cannot be the case since amphetamine also causes a fall in 5-HT storage without inducing sedation. Moreover, patients with carcinoidosis who have very high circulating levels of 5-HT do not exhibit disturbances of the central nervous system.

Prof. F. Smirk described experiments which provided evidence that reserpine might also have a peripheral effect, and Prof. J. H. Burn asked if 5-HT is known to be present in sympathetic ganglia. In reply, Dr. Vogt said she has been unable to detect it, but its presence cannot be excluded.

Dr. W. S. Peart (London) then presented a paper on "Substances Antagonistic to Adrenaline and Noradrenaline", which dealt with the action of the β-haloalkylamines, dibenamine and dibenylene. The latter is active orally. Dealing with the theory that these substances owe their activity to the ethyleneimmonium ion, he pointed out that sodium thiosulphate blocks their action by combining with the ion, but as it also combines with the haloalkylamine, this evidence is inconclusive.

In man the main effects are postural hypotension, meiosis and vasodilatation in the skin. Side effects observed include nasal congestion, nausea and vomiting. His main conclusion was that these substances, which are very potent blocking agents for sympathomimetic effects, have an action which is entirely peripheral, that is, in the arterial wall.

In discussion, Dr. A. C. Dornhorst said that a marked adrenolytic effect can be obtained in man with a dose of 25 mgm. dibenylene, but he is not sure that no effect is produced on the central nervous system. Dr. Ginsburg said she has found that chlorpromazine is more effective against noradrenaline than against adrenaline, but dibenylene is more effective than chlorpromazine against both. Dr. Chapman and Dr. Graham described the results with haloalkylamines. Using purified stable salts of the immonium ions, they showed these to be the active species—a conclusion accepted by Dr. Peart.

Dr. J. G. Widdicombe (London), speaking on "Veratrum Alkaloids", said that they act by eliciting the Bezold reflex, the sensory receptors for which lie in the ventricular muscle of the heart: there was also some evidence for a direct central action. Intravenous injection produces bradycardia and a fall in blood pressure due to peripheral vasodilatation. The cardiovascular effect appears to be mediated by the vagus, since that can be abolished by cutting this nerve. The ventriculo-pressor and pulmonary-depressor reflexes also appear to be involved, but different mechanisms seem to operate in different species.

Dr. Eleanor Zaimis (London) then reviewed "Ganglionic Blocking Substances". A study of the quaternary bases, 'Ecolid' and 139*C*55, and the secondary amine, mecamylamine, showed all three to exert a prolonged action, especially 'Ecolid', but mecamylamine showed better absorption. Dealing with tolerance to the methonium drugs, she pointed out that patients vary in the rates at which tolerance is developed. It appears to bear no relation to the

severity of the disease or to its duration. Repetition of administration of the drugs increases the paralytic effect on the nictitating membrane of the cat; but blood pressure effects tend to be reduced. Hexamethonium appears to potentiate the action of adrenaline. These observations suggest that tolerance may be due to increasing sensitivity of the end organ to adrenaline and not to lack of effect of the methonium compound on the block.

Dr. A. F. Green, opening the general discussion, referred to the new compounds, 139*C*55 and 356*C*54, which are more effective than the -onium compounds in increasing pupil diameter, and have a much longer period of action. The degree of ganglionic blockade depends upon the number of stimuli passing; thus different functions, for example, blood pressure, inhibition of gastric secretion, delay in gastric emptying, may be affected to different extents. Dr. M. Harington described observations on patients under controlled conditions showing that the action of hexamethonium might be potentiated after reserpine.

In opening the third session, "Clinical Applications of Hypotensive Drugs", the chairman, Prof. J. McMichael, apologized for the absence of Prof. Pickering and welcomed Prof. F. Smirk.

The first paper, "Results of Methonium Treatment in Malignant Hypertension: Five Years' Follow-up", was by Prof. J. McMichael (London). Hypertensive patients have been classified into four groups according to the changes occurring in the fundus oculi, their survival being directly related to the extent of such changes. The value of the methonium drugs has been assessed in patients in the worst of these categories, group IV. It was originally planned to use half the patients as controls; but this proved impossible because the improvements in the treated series were so good that treatment could not be withheld from the others.

Hexamethonium has now been replaced by pentolinium given by subcutaneous injection three times daily, but it seems that equally satisfactory results can be obtained by giving a double dose at night and an afternoon injection. If 0·1 mgm. reserpine is given thrice daily, smaller doses of the methonium drugs can be used, with a consequent reduction in the side effects.

Survival depends upon the extent of renal damage, but if the blood urea is not greater than 60 mgm. per 100 ml. there is an even chance of the patient being alive after five years. Of the symptoms associated with hypertension, methonium treatment rapidly clears the retinitis and the headache disappears; the size of the heart diminishes and signs of heart failure are less obvious; attacks of encephalopathy are usually diminished, but the drugs have no influence on hemiplegia or arteriosclerosis.

Prof. F. Smirk (Dunedin) followed with a paper on "Principles and Details in Hypotensive Therapy", in which he said that the aim must be to reduce the blood pressure to normal, but the presence of other lesions may not permit this to be achieved. Impressive reductions in the mortality of hypertensive patients have been obtained using a combination of reserpine and pentolinium by mouth.

The main considerations to be taken into account in initiating hypotensive therapy include: (1) posture: the drugs are more effective when the patient is standing than when lying down; (2) meticulous adjustment of the dose to bring the blood pressure down to 120/80 mm. when maximum effect is exerted; (3) combination of drugs, for example, reserpine (0·5 mgm.) and ganglionic blocking agent; and (4) frequent checks of the response of blood pressure to the doses given throughout the period of treatment using all-day tests.

In reply to Prof. C. Wilson, Prof. Smirk said that side effects are more troublesome in the malignant phase of the disease. If treatment is pressed too hard the patient may abandon it. Some relief may be obtained by trying variations in the drugs used. Dr. Gilchrist asked whether, after obtaining an initial response with intravenous pentolinium in acute cardiac asthma, digitalis provided adequate continuation, whether pentolinium could successfully be combined with hydralazine, and whether pentolinium exacerbated symptoms in a uræmic patient? Prof. Smirk replied that their practice was not to use digitalis, mersalyl, etc., in conjunction with hypotensive drugs, since after intravenous hexamethonium a dramatic response is obtained in 1–1½ minutes. Renal disease is not affected, except indirectly through improvement of the circulation. Dr. B. Hood said that the side effects of hydralazine are unpleasant, but when combined with the ganglionic blocking agents, an enhanced response is obtained.

The last paper of the third session was "Hypotensive Drugs: Clinical Evaluation under Controlled Conditions", by Dr. G. A. Perera (New York). No veratrum alkaloid proves effective unless the dosage is so high that unpleasant side effects are produced. In benign hypertension, pentolinium and hexamethonium have little therapeutic value, while the *Rauwolfia* alkaloids exert benefit by their sedative effects. In the accelerated phase, the *Rauwolfia* alkaloids are of little value, and pentolinium, while it lowers blood pressure, has no effect on renal failure. Hydralazine rarely produces improvement and may cause further renal damage.

Insufficient time has elapsed to assess life prolongation, but it seems that survival is prolonged when there is little kidney damage.

Of three thousand patients who underwent sympathectomy, 40 per cent survived five years. Drugs will probably not improve upon that figure.

Prof. C. Bartorelli (Milan) described his experiences with hexamethonium and reserpine, and Dr. B. Hood (Gothenburg) reported that 90 per cent of his hypertensive patients treated with a combination of reserpine, pentolinium and hydralazine were able to resume work. Prof. McMichael disagreed with Dr. Perera concerning surgical sympathectomy, which in his experience was never complete and seldom reduced blood pressure. A general discussion of the value of oral administration of methonium drugs then followed. Dr. Dornhurst supported Dr. Perera's plea that it is not possible at present to make a final evaluation of these drugs, and Dr. R. W. D. Turner deplored the promiscuous use of drugs in cases in which there was no evidence of hypertensive disease other than raised blood pressure.

The closing session was devoted to "The Control of Vascular Tone in Hypertension", with Prof. Clifford Wilson in the chair.

The first paper, on "Clinical and Experimental Indications", was presented by Prof. Clifford Wilson (London). Except in the case of phæochromocytoma, the primary cause of hypertension is not known. In this case an adrenal medullary tumour secretes an increased quantity of adrenaline and noradrenaline, the actions of which can be inhibited by sympathetic blockade. The blood pressure may remain high

(established hypertension) even after surgical removal of the tumour. The symptoms of essential hypertension are all due to the high blood pressure and spontaneous reversals are rare. Sedation has no effect on the blood pressure. There is no evidence in support of the view that over-production of adrenaline or noradrenaline is responsible, and renal lesions have been excluded as the cause. Obesity increases the tendency, and women tolerate hypertension better than men.

When the renal arteries of rats are clipped, encephalopathy develops, but disappears on removal of the clips.

Whatever the primary cause of the raised blood pressure, when it persists new mechanisms arise leading to the malignant phase of the disease. It seems that some extra-renal factor which leads to the breakdown of renal control is involved.

The next paper was by Dr. B. Folkow (Gothenburg) on "Structural, Myogenic, Humoral and Nervous Factors controlling Peripheral Resistance". The resistance to blood flow of the vessels in the forearm was measured when these were fully dilated under conditions of ischæmia. This resistance is unchanged when the normal person is made acutely hypertensive with noradrenaline, but is increased in patients with essential hypertension. It appears that this may be due to a thickening of the vessel wall.

Dr. M. A. Floyer and Dr. J. M. Ledingham (London) then read papers on "Renal and Extra-renal Factors in Experimental Hypertension". Dr. Floyer described experiments on rats with one kidney clamped and the other removed, from which he concluded that some extra-renal factor under the control of the kidney is responsible. Dr. Ledingham produced evidence in support of the view that the adrenal cortex is involved.

In discussion, Dr. J. Conway (London) concluded that something other than spasm is the cause of increased peripheral resistance, and suggested that methonium drugs might enhance the effect of long-acting nitrites. Dr. R. S. Duff described the results of measurements of the blood flow in the hand under standard conditions, and found that hypertensives are more sensitive to adrenaline. Dr. W. S. Peart used the method of maximum heat elimination to assess the peripheral vasomotor tone. In phæochromocytoma this is much reduced but returns to normal after removal of the tumour, even if hypertension is not relieved.

THE MOTIONS OF THE OUTER PLANETS

FOR his George Darwin Lecture which he delivered last year to the Royal Astronomical Society, Prof. Dirk Brouwer chose for his subject "The Motions of the Outer Planets" (published in *Mon. Not. Roy. Astro. Soc.*, **115**, 3 (1955), and also, slightly condensed, in *The Observatory*, **75**, No. 886 (1955)). Prof. Brouwer discussed four topics : the masses of the outer planets ; accuracy of the numerical integration orbits ; classical planetary theory in rectangular co-ordinates ; and generalized planetary theory.

Masses of the outer planets. For numerical integration the mass of Pluto has been taken as 1/360,000 (the mass of the Sun is the unit throughout), and for the masses of Jupiter, Saturn, Uranus and Neptune those used by Newcomb and Hill have been adopted. A recent investigation by Hertz indicates that the mass of Saturn should be increased by 1 per cent, and from the perturbations of this planet on Jupiter he has obtained for the reciprocal of the mass of Saturn $3497{\cdot}64 \pm 0{\cdot}27$ p.e., which is in excellent agreement with the results derived from satellite orbits. The most comprehensive determination of the mass of Neptune is that made by Eichelberger and Newton from the observations of Triton, but the large difference between the results from visual and photographic observations suggests that there are systematic errors in both. During 1939–42 Alden made a series of photographic observations of Triton with the Yale telescope—at that time in Johannesburg—and the material is now being used at the Yale Observatory with the special object of a new determination of the mass of Neptune. Reference was made by Prof. Brouwer to other new work going on in the study of the satellites of Uranus and Saturn with the main object of finding more-accurate values of the masses of the planets, and preliminary steps for determining Jupiter's mass have been undertaken at the United States Naval Observatory, where observations of thirteen minor planets near the 2/resonance region are in progress. In deriving the mass of Pluto from observations of Uranus, the residuals for the pre-discovery observations are very large ; the result largely depends on Flamsteed's observations in 1712 and 1715, which are not accordant, and rejection of the latter, as favoured by Kourganoff, yields a mass of Pluto comparable with, or greater than, that of the Earth. Brouwer's view is that it is safer to give equal weight to all the pre-discovery observations and to refrain from rejecting any of them. This unexplained deviation in the motion of Uranus largely destroys the confidence in the solution of Pluto's mass from Neptune in which the latitudes of the planet contribute much of the weight, and for this reason it seems advisable to use only the longitudes of Uranus and Neptune.

Accuracy of the Numerical Integration Orbits. As a test of general interest the three area integrals and the energy integral have been evaluated for five dates and the differences from constancy do not reach the last printed decimal place. The available evidence indicates that, for intervals of four centuries for which the numerical integrations were carried out, these orbits are of a quality that would be extremely difficult to attain with general theories. A disadvantage of the numerical integration procedure is that the orbit is determined only for the period for which the integration has been carried out ; but Stiefel has recently discussed a method by which a numerical integration could be related to the general planetary theory. Nevertheless, Brouwer is of the view that the numerical methods "should be looked upon as an aid for testing the results of analytical theories and for stimulating further theoretical developments".

Classical planetary theory in rectangular co-ordinates. A large portion of this section of Prof. Brouwer's lecture was devoted to an explanation of a method described by Dziobek in 1888 : an elliptic reference orbit is selected which nearly coincides with the orbital plane of the perturbed body so that the z co-ordinate is of the order of the perturbations. There is not space in this review to consider the method in detail, and it suffices to say that Davis and Clemence have found it superior to all other methods for perturbations of higher order than the second, and that van Woerkom and Brouwer are now

using it in new theories for Uranus, Neptune and Pluto. Their introduction of certain additional methods has rendered it particularly suitable for automatic calculating machines, and the work has now the highest priority on the computing programme at Yale Observatory.

Generalized Planetary Theory. Although many attempts have been made to solve the planetary theory, there is still no satisfactory representation of planetary motions over long periods of time, and the only completed investigations of this type are solutions of the equations of secular variations. Though limited in scope, they may be suitable as a starting-point towards developing a general analytical theory. For reasons given in Prof. Brouwer's lecture, the choice at present is restricted to the Sun, Jupiter and Saturn, and to simplify the problem, inclinations are ignored. In the actual work the principal task is the development of the disturbing forces as the expansion of negative powers of the mutual distance, and this has been carried out by the staff of the Watson Scientific Laboratory. At the time of the delivery of the lecture, it was not known whether unforeseen difficulties would arise in the solution of the equations for the eccentricities and perihelia, but the indications at the time were favourable.

At the end of his lecture Prof. Brouwer said that much time has been devoted "to an unfinished project" in which team work is important. The work is a joint project of the United States Naval Observatory, the Watson Scientific Computing Laboratory and the Yale University Observatory, supported by the Office of Naval Research. The results obtained so far have been only made possible "by the magnificent support we have received and the unselfish co-operation of everyone concerned".

POPULATION OF BRITISH UNIVERSITIES IN THE 1960's

By Dr. WALLIS TAYLOR
University of Exeter

A REPORT appeared in *Nature* of January 21, p. 115, of the final session of the 1955 Conference of the Universities of Great Britain and Northern Ireland, when the topic discussed was "The Age-group Bulge and its Possible Effect on University Policy". At this Conference, two different estimates of the 'age-group bulge' in the United Kingdom were put forward. It would appear that both these estimates are too small. If this is so, and it is not quickly remedied, it may well result in a failure to make adequate provision for the universities in the next twenty years. I am not including here the increased demand for university education which is likely to come about because of the trend towards larger sixth forms in schools. This is a relevant issue; but at this stage I merely wish to urge a reconsideration of the estimates of the actual number of adolescents which we may expect to be alive in the years 1965 and later.

In the report cited, Dr. G. E. F. Chilver is quoted as saying that during the years 1964–67 we may expect "at least 7,500 more applicants for the universities each year; afterwards there will be a plateau, when the number of applicants will be at least 2,500 more than at present". Prof. R. G. D. Allen found these figures too small, forecasting that at the peak we may expect "more than 105,000, as compared with . . . 80,000 now", and in the plateau after the peak "at least 10–15 per cent higher than now, rising slowly and steadily during the late 1960's and 1970's as the trend towards more seventeen-year-olds at school operates".

While these estimates are in fair agreement about the peak, they diverge sharply in their consideration of the problem of the plateau. In terms of total university population in the United Kingdom (for this is the crucial issue) and if we regard the normal university course as one of three years, Dr. Chilver's estimates represent an increase of 28 per cent at the peak and 9 per cent afterwards in the plateau, whereas Prof. Allen's estimates represent 31 per cent increase at the peak and 10–15 per cent in the plateau. It is not clear from the report how much this discrepancy is due to the omission or addition of those students expected to arise from the trend to later school-leaving; but in any event I believe both estimates to be too small before we add on this extra load.

Since those children who will be the students aged 18, 19 and 20 in the years up to 1975 have already been born, our problem is merely to forecast their survival. The results of this exercise appear in Table 1.

If these figures are of the correct order, then we may expect a potential university population of, at the peak, 40 per cent greater than now, and over a period of eleven years (which includes the peak) a university population which varies between 18 and 40 per cent greater.

The calculations make allowance for the decreasing mortality which this population has experienced. We can check that this allowance is clearly not excessive so far as our present experience is concerned by reference to the Census of Population, 1951. The Census estimated the age-group 15–19

Table 1. Estimated Population of University Age, England and Wales, 1955–72

Year of birth	No. of births	Expected survivors at age 18	Total aged 18, 19, 20 in year stated		Proportion of 1955
1930	648,811	573,000			
1931	632,081	561,000			
1932	613,972	547,000	1,681,000	1950	102
1933	580,413	519,000	1,627,000	1951	99
1934	597,642	537,000	1,603,000	1952	98
1935	598,756	540,000	1,596,000	1953	97
1936	605,292	548,000	1,625,000	1954	99
1937	610,557	555,000	1,643,000	1955	100
1938	621,204	567,000	1,670,000	1956	102
1939	614,479	563,000	1,685,000	1957	103
1940	590,120	543,000	1,673,000	1958	102
1941	579,091	534,000	1,640,000	1959	100
1942	651,503	604,000	1,681,000	1960	102
1943	684,334	636,000	1,774,000	1961	108
1944	751,478	702,000	1,942,000	1962	118
1945	679,937	637,000	1,975,000	1963	120
1946	820,719	772,000	2,111,000	1964	128
1947	881,026	832,000	2,241,000	1965	136
1948	775,306	735,000	2,339,000	1966	142
1949	730,518	695,000	2,262,000	1967	138
1950	697,097	666,000	2,096,000	1968	128
1951	677,529	649,000	2,010,000	1969	122
1952	673,735	647,000	1,962,000	1970	119
1953	684,372	657,000	1,953,000	1971	119
1954	673,657	647,000	1,951,000	1972	119

inclusive to number 2,696,700 at the Census date. This is a very close approximation to the sum of the survivors to age 18 of those born in the years 1932–36 (Table 1). These latter number 2,691,000—a difference of 0·2 per cent. This rather circuitous argument is necessary because no detailed figures of the 15–19 age-group by single years of age are available for England and Wales. It does show, however, that the method is accurate so far as the present population is concerned.

The survival-rates for the later births have been calculated at progressively lower mortality-rates; but the lowest mortality-rates used are taken from the 1950–52 life-table[1]. This gives a conservative estimate of the survivors expected in the future and assumes that the mortality of those under the age of twenty will not fall from the present level. If mortality continues to decrease (as it has done during the past fifty years), we may expect a larger university population than these figures show. It is highly unlikely that anything will cause mortality-rates to be higher in the future than they were in the years 1950–52. The 1950–52 life-tables show that if the mortality-rates of these years continue for the next twenty years, we may expect 96 per cent females and 95 per cent males born in these years to survive to exact age twenty. Clearly mortality-rates cannot fall very much lower; but there is still a certain amount of room for improvement.

Estimates of future births can be, and have been, made to continue the series shown in the table. Briefly, they suggest that the numbers are unlikely to fall very much for some years. In so far as the number of births does fall, this is likely to be compensated in some degree by lower mortality of these later births.

For various reasons we may expect a higher proportion of 18-year olds to reach the required academic standard for entrance to the universities. These estimates, therefore, are likely to be minimal, since no allowance has been made for this factor.

If adequate provision is to be made for university expansion in the United Kingdom to allow the same proportion of each age-group to enter the universities, it is high time that we reached agreement about the expansion needed. I shall welcome, therefore, criticism of these estimates.

[1] Taylor, W., and Dauncey, M., *Brit. J. Prev. Soc. Med.*, **9**, 162 (1955).

SUCCESSFUL SKIN HOMOGRAFTS IN INBRED CHICKENS

By A. G. COCK and MARGARET CLOUGH

School of Agriculture, Poultry Research Field Station, Boxworth, Cambridge

THE skin-homograft reaction, especially in mice[1], has proved to be a very sensitive indicator of slight genetic differences. There is a need for chickens of established antigenic uniformity, for example, in studies of 'immunological tolerance'[2], to which chickens are otherwise well suited. Previous attempts to obtain (without the aid of tolerance) persistent homografts of normal chicken tissues have made use of lines with quite low coefficients of inbreeding (F), and have met with complete failure[3], or only very slight success[4].

We have carried out skin-grafting tests on the I line of White Leghorn from the National Poultry Institute Northern Breeding Station, Reaseheath, Cheshire. Following an early history of irregular inbreeding in the United States, this line has been maintained since 1939 exclusively by full-sib matings[5]. The chicks used by us have an F of 98·75 per cent (slightly more than the equivalent of twenty generations of full-sibbing). Some use has also been made of two other inbred lines from Reaseheath: the C line (White Leghorn, $F = 98{\cdot}91$ per cent) and the M line (Rhode Island Red, $F = 78{\cdot}5$ per cent). The technique used in grafting was essentially that of Cannon and Longmire[6], with minor changes in the siting and orientation of the grafts. Homografts (approximately 1 cm. square) were exchanged between pairs of chicks, and each chick received in addition an autograft of its own skin. All grafts were made 13–14 days after hatching, this being safely beyond the age at which a foreign graft may sometimes survive by conferring tolerance on the host[2,5].

We have not succeeded, even with autografts, in obtaining a uniformly satisfactory 'take'. There has been conspicuous variation in the amount of tissue successfully healed-in (judged by the number of feathers) and some variation in the promptness with which feather-growth was initiated. A series of arbitrary grades has been used to express this variation in the 'vigour' of grafts: grade 3 for grafts which have been in every way unexceptionable; grade 2 for minor, and grade 1 for major deficiencies. Grade 0 covers grafts which disappeared at an early stage without having shown clear signs of an immunological reaction. Grade R is reserved for cases in which a typical and unmistakable homograft reaction was observed.

Three types of homograft have been used in testing the I line: (*a*) donor and host full sibs; (*b*) donor and host both pure I, but having the great-grandfather as latest common ancestor; (*c*) I donor on F_1 ($C♂ \times I♀$ or $M \times I$) host, with the grandmother as latest common ancestor. A miscellaneous group, in which one or both parents of the donor are foreign to the host line(s), serves as control material. Table 1 shows the results according to grades.

The controls confirm earlier findings[2,6] that a rapid and violent homograft reaction normally occurs in

Table 1

	Grades (see text)					
	3	2	1	0	R	Total
(*a*) I on I (full sibs)	28	21	7	3	—	59
(*b*) I on I (non-sibs)	6	5	1	2	—	14
(*c*) I on $C \times I$ or $M \times I$	7	3	2	1	—	13
Total homografts testing I line	41	29	10	6	—	86
Autografts on same hosts	58	17	4	7	—	86
Miscellaneous controls (I on C, $C \times I$ on I, $C \times I$ on $M \times I$, etc.)	—	—	—	6	26	32
Autografts on same hosts	23	4	2	3	—	32

chicks of this age. In all but one of the twenty-six grade *R* cases destruction of the graft was complete by 9–12 days after grafting. (It is perhaps significant that in the remaining case, where the graft survived for about 20 days, the host was a very stunted individual.)

In contrast, only six of a total of eighty-six *I* line homografts have failed to survive, an incidence no higher than among the autografts on the same hosts. The remaining eighty have shown every sign of being permanent. All were inspected regularly for at least fifty days after grafting; all but nine were kept under observation for periods in excess of five months, and some, on hosts retained for breeding, are now of more than a year's standing. The only aspect of the results which suggests that the tissue antigens of the *I* line are not completely uniform is the lower proportion of homografts in grade 3, in comparison with the autografts. While the purely statistical significance of this difference is undoubted ($\chi_1^2 = 6{\cdot}65$, $P \simeq 0{\cdot}01$), it must be remembered that the 3–2–1 grading is necessarily somewhat subjective. If slight differences in tissue antigens exist within the *I* line, they merely make homografts more susceptible to unfavourable conditions of healing, without prejudicing the survival or well-being of tissue that has passed the healing-in stage. There is, moreover, no indication that homografts are less successful when donor and host are less closely related within the *I* line: the results of types (*a*), (*b*) and (*c*) are substantially identical. In this, and in the lack of any qualitative deficiencies peculiar to the homografts, the situation differs from that described by Billingham *et al.*[1] in certain inbred lines of mice yielding low-grade homograft reactions.

While it is thus open to question whether or not the *I* line is completely uniform in respect of tissue antigens, it at least approaches sufficiently close to uniformity for most experimental purposes. However, our colleague, Dr. D. G. Gilmour, informs us that recent agglutination tests show the *I* line to be segregating for at least one pair of alleles determining different red-blood-cell antigens, which suggests that the two types of antigen are genetically, as well as immunologically[2], quite distinct.

Owing partly to poor fertility and selective mating among the breeding stocks, results bearing on the uniformity of tissue antigens within the *C* and *M* lines are few in number and mostly indirect, being based on grafts exchanged between F_1 hybrids. They suggest, however, the tentative conclusion that the *C* line is considerably less uniform than the *I* line, whereas the *M* line (in spite of its much lower *F*) seems to be comparable in uniformity with the *I* line.

[1] Billingham, R. E., Brent, L., Medawar, P. B., and Sparrow, E. M., *Proc. Roy. Soc.*, B, **143**, 43 (1954).

[2] Billingham, R. E., Brent, L., and Medawar, P. B., *Phil. Trans. Roy. Soc.*, B, **239**, 357 (1956).

[3] Loeb, L., "The Biological Basis of Individuality", p. 60 (Springfield, Illinois, 1945).

[4] Kozelka, A. W., *Physiol. Zool.*, **6**, 159 (1953).

[5] Pease, M., Proc. 8th World's Poultry Congress, Copenhagen, **1**, 33 (1948).

[6] Cannon, J. A., and Longmire, W. P., *Ann. Surg.*, **135**, 60 (1952).

MICROSCOPICAL MEASUREMENTS OF OPTICAL PATH-DIFFERENCE BY MEANS OF COLOURED BIREFRINGENT INTERFERENCES AND A NEW COMPENSATION METHOD

By L. P. JOHANSSON

Institute of Optical Research, Stockholm 70

AND

B. M. AFZELIUS

Palynological Laboratory, Ranhammarsvägen 22, Bromma

THE optical path-difference given by the light when it passes through small objects in a microscope may be measured by means of a wave-shearing interferometer as originally proposed by Jamin[1] and using a Savart plate according to Françon[2].

The measuring device which we use is a Françon eyepiece in which the thickness of the Savart plate is chosen in order to give a sideways displacement between the two interfering wave-fronts somewhat larger than the enlarged image of the object detail to be measured. The eyepiece is combined with a measuring device designed by one of us (L. P. J.) with a reference area incorporated into the field of view.

Fig. 1 shows the optical components in the microscope. The white light from a thin slit goes as a parallel beam through the object. Any good normal objective may be used. After the lens L_2 the light goes as a parallel beam through the Savart plate, placed between two crossed 'Polaroids' P_1 and P_2. The device for measuring the optical path-difference is placed at image 1. This device consists of a rotatable glass wedge and is thus isotropic, which is a great advantage over birefringent compensators. Lens L_4 gives at image 2 a new image of the object and an image of the wedge. Fig. 3 shows the field of view, where a double image of the object is seen. In Fig. 2 the same object is photographed in an ordinary microscope.

Different optical path-differences in the two images give rise to different interference colours on the Newtonian scale equally distant on both sides of the coherent background colour. By turning the wedge the light passes through the Savart plate at different angles, and the colour will be changed. A hole in the middle of the wedge through which the undistorted background appears serves as a reference. To measure the optical path-difference of part *a* in Fig. 3 the colour of a_1 is made equal to the reference colour by turning the wedge a certain angle β from the zero point. If also the second image is free, or by rotation of the microscope table can be made free, from other parts of the object, as in a_2, etc., its colour is compensated by turning the wedge in the

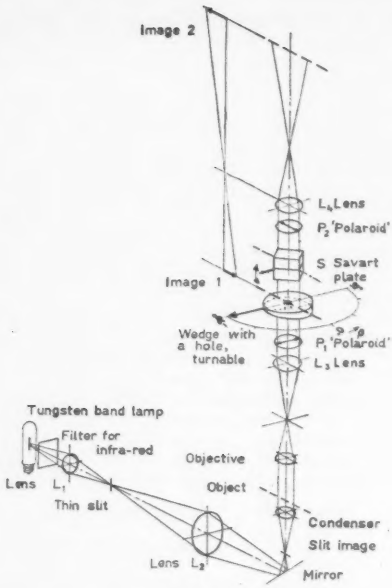


Fig. 1.

opposite direction. The angle between the two settings is then 2β. We then obtain: optical path-difference = constant $\times \sin \beta$.

The constant depends on the glass wedge and the Savart plate used. The range of measurement can be altered by choosing different wedges. In order to obtain the highest possible accuracy, the colours of the field of view should be even. That means that the light is parallel through the Savart plate. The Savart plate also has to be adjusted to give the background, 'the sensitive colour' (purple-violet) of the first order[3]. Under ideal conditions, an accuracy (maximum error) of about $\pm$ 10 A. in optical path-difference can be obtained. Ideal conditions mean a relatively large detail of the object for comparison; the detail ought also to be uniform. If the object is

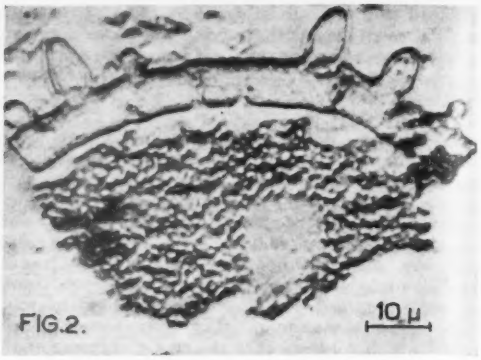


Fig. 2. Section through part of osmium-fixed pollen grain of *Althaea rosea*. Geometrical thickness of the section, 4800 A.

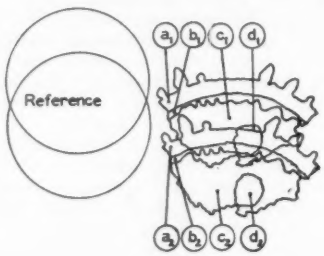


Fig. 3

not regular, the accuracy will, of course, not be so high. The method has been tried for measuring the optical path-difference of various objects; for example, thin films of evaporated zinc sulphide, small grooves etched in glass (these may be used as a standard object), silver bromide crystals in photographic emulsions and blood corpuscles. It is also possible to use the same compensation method for measuring the optical path-difference by reflexion microscopy; for example, for studying metallographic surfaces.

Table 1. Optical Path-differences (in A.)

Mean value of ten settings and the standard deviation of the settings. The Roman numerals indicate different glass wedges used

	Extine (*a*)	Intine (*b*)	Cytoplasm (*c*)	Part of nucleus (*d*)
Section of osmium-fixed pollen grain of *Althaea rosea*	in air (III) 2260 ± 62 in water (II) 925 ± 48 (III) 880 ± 75	in air (II) 765 ± 20 (III) 640 ± 80 in water (II) 260 ± 30 (III) 275 ± 82		in water (II) 1060 ± 20 (III) 1025 ± 85
A second section of *Althaea rosea*	in air (III) 2125 ± 160 in water (III) 1260 ± 43 (III) 1200 ± 48	in water (III) 435 ± 63 (III) 400 ± 60		
A third section of *Althaea rosea*	in air (IV) 2450 ± 65 in water (III) 910 ± 34 (III) 880 ± 85 (IV) 850 ± 105		in air (IV) 1775 ± 120	
Section of pollen grain of *Cobea penduliflora* preserved in acetic acid	in air (IV) 1140 ± 75		in air (IV) 875 ± 150	
Section of acetolysed microspore of *Regnelliidium diphyllum*	in air (III) 825 ± 56 (IV) 775 ± 65 in water (III) 290 ± 65			

More complete descriptions of apparatus and measurements will be published elsewhere. The apparatus is being manufactured and will be put on the market by Jungnerbolaget, Stockholm 14.

As an example of the uses of this instrument, we give some measurements of the optical path-differences of different cell components in thin sections of pollen grains and spores measured in air and water, respectively. The sections were made on a Spencer microtome modified for thin sectioning at the Palynological Laboratory in Bromma, Sweden. No measurable anisotropy was found in these objects.

The pollen wall consists principally of two layers, exine (*a*) and intine (*b*). The difference in optical path-difference between the exine and the intine is clearly shown in Table 1 and is tolerably constant. In a well-fixed grain the cytoplasm (*c*) comes out in various colours. The optical path-differences of the cytoplasm given in the table are mean values obtained by integration over the whole area. On account of the heterogeneity of the cytoplasm, it is, of course, of less value to give a mean value of its optical path-difference, and it might be possible to measure different cytoplasm components.

Some measurements from part of a nucleus (*d*) are given. This part of the nucleus gives a greater optical path-difference than the exine. It must be borne in mind, however, that the exine does not stain with osmium tetroxide[4], whereas the nucleus does. [Feb. 27

[1] Jamin, M. J., *C.R. Acad. Sci., Paris*, **67**, 814 (1868).
[2] Françon, M., *Opt. Acta*, **1**, 50 (1954).
[3] Ingelstam, E., and Johansson, L., *Opt. Acta*, **2**, 139 (1955).
[4] Afzelius, B. M., Erdtman, G., and Sjöstrand, F. S., *Sv. Bot. Tidskr.*, **48**, 1 (1954).

GROWTH OF SUCROSE CRYSTALS

By H. E. C. POWERS
Tate and Lyle, Ltd., Thames Refinery, London, E.16

THE manner of growth of cane or beet sugar crystals resembles in many ways that observed on crystals of many salts by Bunn and Emmett[1], and first reported at the Faraday Society Discussion on Crystal Growth at Bristol in 1949. These authors observed, in the light microscope, layers 1000 A. or more in thickness spreading over the faces of growing crystals of many salts and a few organic substances containing strongly polar groups, but did not see them on sucrose crystals. I have found, however, that on sucrose crystals growing on a microscope slide at room temperature in syrup of 1·05–1·3 supersaturation, layers can be seen spreading over the various faces (Figs. 3,4). Perhaps those on 100, 101 and 001 are the most perfect, while the 'end' faces 110, etc., sometimes suggest rather an 'end grain' effect, which with any encouragement develops into a castellated type of multi-crystal development. In some cases the layers may be seen to spread outwards from some origin in the mid-section of the face, and other phenomena seen by Bunn and Emmett which are also exhibited by sucrose crystals are the 'wrapping over' of a layer on to a neighbouring face, and the formations of pits by layer encirclement. No definite signs of growth by the screw dislocation mechanism have yet been seen.

To facilitate the recognition of the faces to which references have been made, two diagrams (Figs. 1 and 2) have been reproduced, the one the simplest or most perfect sucrose crystal, the other a more complex form which illustrates faces which may develop under different conditions of growth.

Electron micrographs of a cleavage face parallel to 100, at a magnification of 20,000, show a stepped structure, perhaps related to layer growth (Fig. 6). Some micrographs show a kind of mosaic structure; the first such micrograph was shown to me by Dr. van Hook, who used an alcohol etched surface, and a similar mosaic structure was also shown by some more of the micrographs kindly prepared for me by the Associated Electrical Industries Research Laboratories, using the above internal cleavage face (Fig. 5). Further work is necessary and is in progress; but it seems to me that these results do indeed indicate probable internal structure, particularly since X-ray photographs by the above Laboratories also showed diffuse reflexions which could indicate crystallite formation or extensive imperfections.

A phenomenon of considerable technological importance which depends upon the mechanism of crystal growth is the presence of water inside the crystals. Vapour pressure measurements before and after crushing prove the presence of relatively pure sucrose solution inside the crystals as distinct from the thin layer of relatively exhausted low-purity syrup remaining on the surface of 'dry' sucrose crystals. The proportion of water present increases rapidly with the size of crystal, normal granulated sugar crystals of about 0·5 mm. length having only 0·01 per cent, while crystals of 25 mm. length may have as much as 0·4 per cent. Some of this water is present in cavities large enough to be seen in the light microscope (Fig. 7), which would be seen more frequently in large than in small crystals, but the possibility that some of it is trapped between layers or in mosaic cracks cannot be overlooked. There is an intriguing problem awaiting solution as to the

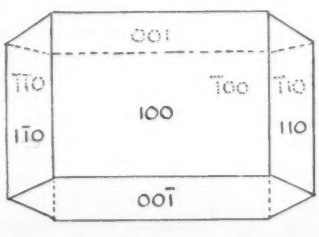


Fig. 1. The simplest eight-faced sucrose crystal

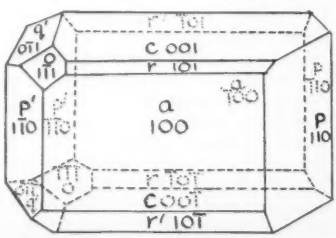


Fig. 2. The more complex form, which may have up to eighteen faces

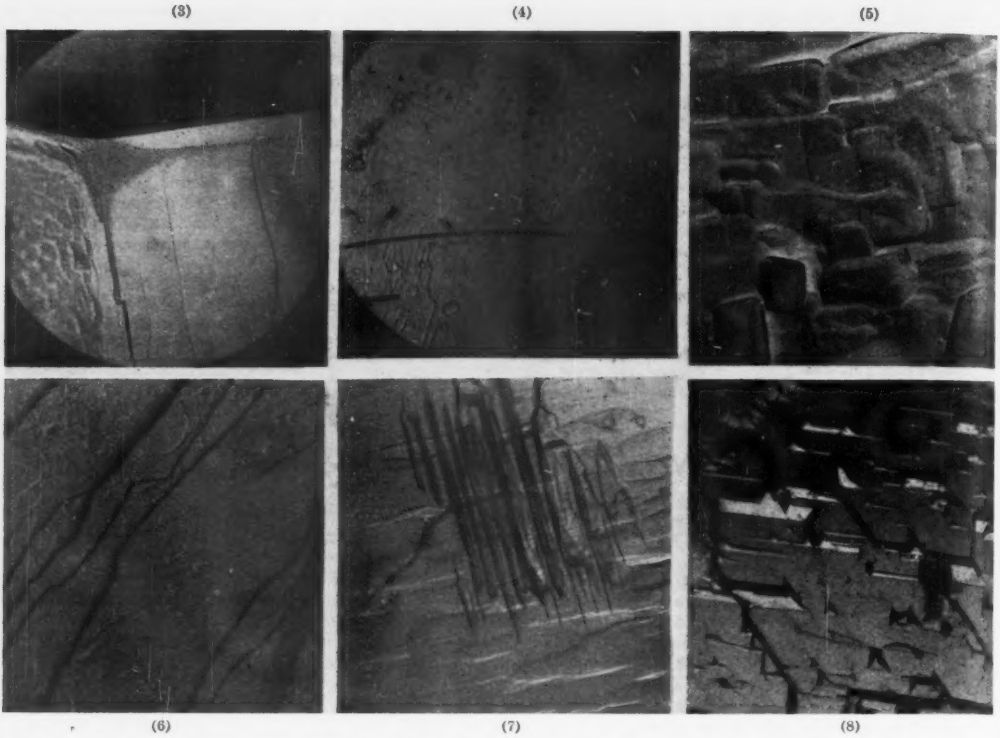


Fig. 3. Layer growth repairing a broken corner. Fig. 4. More complex layer growth—a particularly fortunate photograph which illustrates how the liquor intrusion may originate. Fig. 5. Electron micrograph of cleavage face parallel to 100 face. Fig. 6. Electron micrograph of cleavage face parallel to 100 face. Fig. 7. Internal liquor in fjord-like formation also showing layers. Fig. 8. Tesselated surface of 100 produced by growing in agar

The photomicrographs are × *c.* 40, the electron micrographs × *c.* 20,000. Acknowledgment is due to the Associated Electrical Industries Research Laboratories for permission to publish the electron micrographs

mechanism of the layer growths enclosing these liquor intrusions.

When sucrose crystals are grown in static agar gel (to damp down free syrup movement), growth does not occur by the spreading of the layers right across the faces; there is a striking surface development I have termed 'tesselated' (Fig. 8). There is a large number of independent growth centres on each face, each bounded by what appears to be 101, $10\bar{1}$, etc., facets. Prof. Tolansky is examining the interfacial angles of these tesselations to see if they do indeed correspond to the normal side faces. Other gelling agents produce similar effects, which, therefore, are probably not due to a surface adsorption effect, but to an interference with that movement of solution which may play so vital a part in normal layer growth.

A study of nucleation of sucrose has also provided certain features which may be of interest. A single large crystal was attached to an axis which was then rotated at varying speeds in a nuclei-free solution of known supersaturation. The resulting solutions were cooled to assist nuclei to grow. Counts were then made of nuclei produced under different conditions. At sufficiently high speed, nucleation appears to be produced virtually in a saturated solution. At the suggestion of Dr. C. W. Bunn, a 'Perspex' model was then used in place of the sucrose crystal. Nucleation was effected under these conditions at a speed of several hundred revolutions per minute and 1·2 supersaturation. It appears to me that a plausible theory to account for this latter phenomenon is that the violent movement produces a periodic node and antinode distribution in the normally uniform distribution of sucrose and water molecules in solution, thus increasing the statistical chances of true nuclei being formed by the excessive local supersaturation. I find that a similar theory was put forward by the Earl of Berkeley, but this does not appear to be widely known.

It also appears a tenable hypothesis that the nuclei produced by shedding from a pre-existing crystal are larger initially than those produced in absence of any pre-existing crystal and that this accounts for the difference in the borderline supersaturation. Further, there is some slight evidence that in concentrated sugar solutions there may exist formless aggregates of molecules which have not yet attained regular crystal lattice formation.

I wish to attract the attention and collaboration of others carrying out similar researches upon substances other than sucrose, since it is becoming increasingly evident that allied phenomena are being discovered in the crystallization of substances so dissimilar as inorganic salts, metals (from melts) and non-polar organic substances such as sucrose. Prof. J. Bernal, at a recent conference in Oxford, directed attention to the desirability of more intensive study of non-polar molecular crystals.

[1] Bunn and Emmett, *Trans. Farad. Soc.*, **5**, 119 (1949).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Immunity of Lysogenic Bacteria

BACTERIAL virus (phage), in its symbiotic phase (prophage), renders the host bacterium lysogenic, and confers on it immunity against lysis by free phage particles of the homologous type, whether temperate or virulent in character. Hyper-virulent mutants, which are rare, may be exceptions to this rule.

Earlier work suggested that this immunity might cover not only homologous phage but also phages of related types. An extensive survey of the *A* phages of *Salmonella typhi-murium* (which form a closely related group) shows that this conception needs revision. Some cross-immunity does exist, but it is far from being universal or complete. Four different reactions have been found.

(1) Reciprocal cross-immunity may be absolute, so that lysogenic bacteria carrying prophage *L* and lysogenic bacteria carrying prophage *M* (the letters used are symbols only, and do not refer to named phages) are equally resistant to temperate particles of phages *L* and *M*. Neither lysis, nor any change in lysogenesis, occurs, although the free particles may be well adsorbed.

(2) There may be reciprocal sensitivity. Thus, when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *N* or, vice versa, when lysogenic bacteria carrying prophage *N* are exposed to temperate particles of phage *L*, some bacteria may be lysed while others may become doubly lysogenic, and carry both prophages *L* and *M*.

(3) One phage may be partly dominant over the other. In this case, when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *O*, they show complete resistance; but when bacteria carrying prophage *O* are exposed to temperate phage particles of phage *L*, some bacteria are lysed and others survive, showing double infection with prophages *L* and *O*.

(4) One phage may be completely dominant over the other. Thus when lysogenic bacteria carrying prophage *L* are exposed to temperate particles of phage *P*, they show complete resistance: but when lysogenic bacteria carrying prophage *P* are exposed to temperate particles of phage *L*, some are lysed, while in others phage *L* evicts and replaces prophage *P*, so that the surviving bacteria carry only prophage *L*. Sometimes, however, a few of the surviving bacteria are phage-free; the strong phage has apparently turned out the weak, but has failed to take its place, so that the bacterium has been 'cured'.

Certain of the 'cured' bacteria recovered in this way are very efficient indicators. The first to be encountered, strain *Q*1, supports the growth of all the identified phages of *S. typhi-murium*. Hitherto it has been necessary to use two different indicator strains (for some time suspected to contain weak symbiotic phage) to isolate the complete series; this has made exact comparisons of the phages difficult. It is an easy matter to prepare pure suspensions of these temperate phages, and with them to produce lysogenic strains of *Q*1 which are alike except for their prophage content. These lysogenic strains have a specific immunity which provides a delicate means of identifying phages. A test, based on this principle, has revealed differences which were hitherto unsuspected, and has greatly enhanced the accuracy of the method of 'typing' bacteria by determining the prophages they carry.

In the course of these experiments no 'hybrid' phages have been found; but a much larger number of colonies would need to be examined before the possibility of their occurrence could be definitely excluded. Certain of the free phage preparations contain a non-particulate lytic principle which acts on some strains of lysogenic bacteria and not on others. This also has still to be investigated.

J. S. K. BOYD

Wellcome Laboratories of Tropical Medicine,
183–193 Euston Road,
London, N.W.1.
March 29.

Role of Non-Protein Nitrogen in the Synthesis of Hæmoglobin in the Reticulocyte *in vitro*

A CONSIDERABLE increase of non-protein nitrogen takes place when washed suspensions of red cells of anæmic rabbits, which are rich in reticulocytes, are incubated in physiological saline. This does not occur in suspensions from animals which are low in reticulocytes (see Table 1). The relation between increase of non-protein nitrogen and respiration, which is indicated by the data, is further borne out by the observations that: (*a*) increase of non-protein nitrogen is lower under anaerobic conditions (Table 2); (*b*) that it is inhibited by 2,4 dinitrophenol (Table 3).

Table 1

Reticulocytes per cent	Medium	O_2-consumption mm.$^3O_2$/h./ml. cells	NPN mgm./ml. cells/6 h.
1·5	NaCl	16·5	+0·08
18·1	NaCl	164·5	+0·51

Red cells of rabbits, made anæmic by repeated bleeding, were used. They were washed three times with isotonic sodium chloride solution. One part of washed cells was suspended in 3 parts of medium and incubated in Warburg vessels at 37·5°

Table 2

Medium	Conditions	NPN mgm./ml. cells/6 h.
NaCl	Aerob.	+0·27
	Anaerob.	+0·08

Conditions as in Table 1

Table 3

Medium	Conditions	Δ NPN mgm./ml. cells/6 h.
NaCl	Aerob.	+0·33
+2,4 DNP (final concentration 10^{-4} *M*)	,,	−0·04

Conditions as in Table 1

Table 4

Medium	Conditions	Δ NPN mgm./ml. cells	Δ Hb. mgm./ml. cells
NaCl	Aerob.	+0·27	0
Phosphate+glucose +11 amino-acids	,,	+0·05	+9·8

Conditions as in Table 1

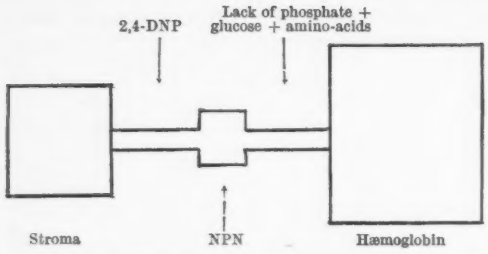


Fig. 1. Scheme of hæmoglobin formation with inhibitory effects

In the presence of phosphate, glucose and eleven essential amino-acids, non-protein nitrogen increases only minimally (Table 4); on the other hand, new formation of hæmoglobin is observed. No increase of hæmoglobin takes place in saline alone.

The stroma is the source of both non-protein nitrogen and newly formed hæmoglobin[1]. Thus the formation of hæmoglobin may be considered as a process of transformation of one protein (stroma) to another with an intermediate non-protein nitrogen phase. Fig. 1 shows a scheme which summarizes the observed effects. It indicates that lack of phosphate, glucose and amino-acids blocks the synthesis of hæmoglobin from non-protein nitrogen, while addition of 2,4-dinitrophenol inhibits breakdown of stroma.

Two points may be made: (1) The same conditions are necessary for hæmoglobin synthesis that have proved optimal for the breakdown of the substantia reticulo filamentosa, which is a specific ribonucleic acid[2]. A relation between *breakdown* of ribonucleic acid and synthesis of protein is suggested. (2) The effect of 2,4-dinitrophenol suggests a connexion between breakdown of protein, that is, non-protein nitrogen accumulation and oxidative phosphorylation. A similar relation is assumed for the breakdown of ribonucleic acid[3].

H. G. Schweiger
S. Rapoport
E. Schölzel

Institute of Physiological Chemistry,
Humboldt University,
Berlin, N.4.

[1] Experimental results to be published.
[2] Coutelle, R., Rapoport, S., and Lindigkeit, R., *Naturwiss.*, **42**, 127 (1955).
[3] Rapoport, S., Schweiger, H. G., and Strassner, W. L., *Naturwiss.*, [**43**, 18 (1956)].

Recovery from Irradiation following the Administration of Cultured Tissues

CBA mice which have been given a lethal dose of X-rays recover if treated with intravenous injections of spleen cells from infant mice. Barnes and Loutit[1] have shown that this therapeutic activity can be preserved by storing fragments of such spleen with glycerol at − 79° C.

Storage of whole spleens *in vivo* in the peritoneal cavity of mice does not preserve the activity.

Tissue culture of fragments of infant spleen and of embryo liver preserves activity for some days. These tissues were cultured in a basic medium of rabbit serum and glucose, using Trowell's culture-cup technique[2] and, more recently, a modification of Chen's lens-paper technique[3]. The latter gave better mechanical recovery of explants.

Table 1. Post-irradiation Protection by IV Injection of Tissue Cultures

Injected material	30-day survival	Per cent survival
1. Cultures (*CBA* mice)		
Infant spleen, rabbit serum/glucose, 48-hr. culture	11/15	73·3
As above, 'wandering cells'	0/5	0
Embryonic liver, rabbit serum/glucose		
48-hr. culture	56/93	60·2
72-hr. culture	3/5	60
96-hr. culture	3/5	60
As above, 'wandering cells'		
48-hr. culture	0/5	0
72-hr. culture	5/15	33·3
5-day culture	0/5	0
Embryonic liver, synthetic medium, 48-hr. culture	1/10	10
Embryonic liver, heat-inactivated rabbit serum/glucose, 48-hr. culture	0/10	0
2. Controls		
Fresh rabbit serum	1/105	0·95
Rabbit serum/saline	0/5	0
Saline	0/30	0
Culture medium	0/35	0

Results are given in Table 1. The cultured embryonic liver is active for as long as four days of culture, although two days has been taken as a standard culture time. Cells which drop out or wander from the explant into the culture medium are variably active, depending upon the duration of culture.

Cultures in synthetic medium[4] or fresh rabbit serum-glucose which has been inactivated at 56° C. for half an hour are not active. Their gross and histological appearance is excellent, however.

Controls usually die by the fourteenth day following irradiation and injection. In treated mice, the survivors live for many months.

Active cells are known to be hæmatopoietic in nature[5,6] and preliminary experiments indicate that the failure of heat-inactivated and synthetic media to produce active cells may be due to a deficiency of a principle for stimulation of hæmatopoiesis.

I wish to thank Dr. D. W. H. Barnes and Dr. J. F. Loutit for advice and assistance in this work.

Carol L. Miller

Medical Research Council
Radiobiological Research Unit,
Atomic Energy Research Establishment,
Harwell.
June 8.

[1] Barnes, D. W. H., and Loutit, J. F., *J. Nat. Cancer Inst.*, **15**, 901 (1955).
[2] Trowell, O. A., *Exp. Cell. Res.*, **3**, 79 (1952).
[3] Chen, J. M., *Exp. Cell Res.*, **7**, 518 (1954).
[4] Trowell, O. A., *Exp. Cell Res.*, **9**, 258 (1955).
[5] Lindsley, D. L., Odell, Jun., T. T., and Tausche, F. G., *Proc. Soc. Exp. Biol. and Med.*, **90**, 512 (1955).
[6] Ford, C. E., Hamerton, J. L., Barnes, D. W. H., and Loutit, J. F. *Nature*, **177**, 452 (1956).

Metabolism of Glycerol, Sorbitol and Related Compounds by Spermatozoa

The finding that the addition of glycerol to semen increases considerably the proportion of spermatozoa which survive freezing and storing at − 79° C.[1,2] opened up the question as to whether or not glycerol can be metabolized by the intact sperm cells. Early experiments indicated that, unlike certain glycolysable sugars and organic acids, glycerol, in common with other alcohols, has no marked initial-rate preserving

effect on the sperm respiration[3], and exerts its action mainly through a protective influence on sperm colloids, probably owing to its high electrolyte- and water-binding capacity[4,5]. More recent investigations, however, have shown that although glycerol does not affect sperm motility and respiration in a diluent containing fructose, it increases markedly the oxygen consumption of washed sperm suspensions, giving rise at the same time to significant quantities of lactic acid[6]. It has also been demonstrated that glycerol labelled with radioactive carbon enters spermatozoa in measurable amounts; sperm cells separated from the seminal plasma showed a higher uptake and utilization of glycerol than did spermatozoa in the presence of seminal plasma[7]. The present study was undertaken to investigate: (1) the relationship between glycerol disappearance and lactic acid formation; (2) the behaviour of compounds related to glycerol such as dihydroxyacetone and phosphoglycerol. Glycerol was determined colorimetrically[8], and the other methods used were those described earlier[9].

The results, which are based on experiments with ram spermatozoa, are briefly as follows.

(1) Glycerol (0·01 *M*) is utilized aerobically by suspensions of washed spermatozoa (3×10^8 cells/ml.) at a rate of about 1 mgm./10^9 sperm/hr. at 37° C. The disappearance of glycerol is accompanied by an increase in the oxygen uptake, of the order of 0·1–0·3 ml. O_2/10^9 sperm/hr., and by the accumulation of lactic acid, which appears to be an intermediary product in the oxidative breakdown of glycerol.

(2) The extent to which lactic acid accumulates depends on the concentration of phosphate used for the preparation of the sperm suspensions. It is about 0·4 mgm. lactic acid/10^9 sperm/hr. in the presence of phosphate buffer *p*H 7 (0·08 *M*) as compared with 0·0·1 mgm./10^9 sperm/hr. in the absence of phosphate. A higher rate of lactic acid accumulation in the presence of phosphate coincides with a lower oxygen uptake; this is due to a depressing effect of phosphate on the oxidation of lactic acid by spermatozoa.

(3) The breakdown of glycerol is a function of live spermatozoa and can be abolished either by heating or by the addition of spermicidal agents, for example, cetyltrimethylammonium bromide. It is not affected by the addition of penicillin. There is little or no disappearance of glycerol under anaerobic conditions. Glycerol has no appreciable effect on the rate of anaerobic fructolysis in sperm suspensions to which fructose has been added; but it exerts a 'sparing effect' on the aerobic fructolysis.

(4) In the normal course of glycerol oxidation, both in the presence as well as in the absence of phosphate, there is little or no accumulation of bisulphite-binding substances. However, such substances, mostly alkali-stable, can be shown to accumulate in the presence of sodium fluoride (0·02 *M*), particularly when glycerol is used in a high concentration (0·1 *M*). Moreover, when glycerol is replaced by dihydroxyacetone (0·01 *M*), the oxygen uptake of spermatozoa is increased and lactic acid is formed in about the same amounts as from glycerol. Phosphoglycerol (both α- and β-) is dephosphorylated by washed ram spermatozoa anaerobically as well as aerobically. Whereas, however, anaerobically glycerol accumulates as the final product of the enzymic dephosphorylation of phosphoglycerol, aerobically it is oxidized further, thus increasing the oxygen consumption of spermatozoa. Unlike phosphoglycerol, glycerylphosphorylcholine has no effect on sperm respiration.

(5) Apart from glycerol, a number of other alcohols have been tested as well as inositol, mannitol, dulcitol, erythritol and sorbitol. Sorbitol was the only one which produced a marked increase in the oxygen uptake of washed spermatozoa. The oxidation of sorbitol (0·01–0·1 *M*) was accompanied by the formation of lactic acid and a yeast-fermentable ketosugar which was identified as fructose. The ketose appears in considerable amounts when a high concentration of sorbitol (0·1 *M*) is used or else when the sperm suspension contains a low concentration of sorbitol (0·01 *M*) together with an equally low concentration of glycerol.

This investigation was carried out on behalf of the Agricultural Research Council; one of us (I. G. W.) is indebted to the Australian Council for Scientific and Industrial Research for a fellowship.

T. Mann
I. G. White

Agricultural Research Council Unit of
Reproductive Physiology and Biochemistry,
Molteno Institute,
and
Department of Veterinary Clinical Studies,
University of Cambridge.

May 10.

[1] Polge, C., Smith, A. U., and Parkes, A. S., *Nature*, **164**, 666 (1949).
[2] Polge, C., and Rowson, L. E., *Vet. Rec.*, **64**, 851 (1952).
[3] Humphrey, G. F., and Mann, T., *Biochem. J.*, **44**, 97 (1949).
[4] Lovelock, J. E., and Polge, C., *Biochem. J.*, **58**, 618 (1954).
[5] Mann, T., "The Biochemistry of Semen" (Methuen, London, 1954).
[6] White, I. G., Blackshaw, A. W., and Emmens, C. W., *Aust. Vet. J.*, **30**, 85 (1954).
[7] O'Dell, W. T., Flipse, R. J., and Almquist, J. O., *J. Dairy Sci.*, **39**, 214 (1956).
[8] Ryley, J. F., *Biochem. J.*, **59**, 353 (1955).
[9] Mann, T., *Biochem. J.*, **40**, 481 (1946).

Metabolism of Lysergic Acid Diethylamide

Although the hallucinogenic agent, lysergic acid diethylamide, has been the subject of numerous investigations, little is known about its biological fate. The development of a specific and sensitive method for the estimation of lysergic acid diethylamide in biological materials has enabled us to study its physiological disposition and metabolism.

Lysergic acid diethylamide was extracted from a salt-saturated alkaline solution of biological material into heptane containing 2 per cent *iso*amyl alcohol. The compound was returned to dilute hydrochloric acid and the fluorescence measured in a Farrand or Bowman spectrophotometer[1] at 445 mμ after activation at 325 mμ. As little as 0·001 μgm. of lysergic acid diethylamide could be determined by this method. Concentrations of the drug greater than 5 μgm. per ml. may be measured spectrophotometrically at 310 mμ.

After the administration of lysergic acid diethylamide to a cat, the drug was found in all tissues in the following order of decreasing concentrations: bile, plasma, lung, liver, kidney, brain, cerebrospinal fluid, spleen, intestine, muscle and fat. From tissue distribution studies, it was calculated that lysergic acid diethylamide exerted its psychological effects in man at a concentration of 0·0003 μgm. per gram of brain tissue.

Lysergic acid diethylamide was almost completely transformed when administered to the intact animal,

Table 1. The Enzymic Transformation of Lysergic Acid Diethylamide

Additions	LSD metabolized (μmole)
Microsomes + soluble fraction	0·53
Soluble fraction	0·00
Microsomes	0·04
Microsomes + 35 μmoles of glucose-6-PO_4	0·04
Microsomes + 35 μmoles of glucose-6-PO_4 + 1 mgm. of glucose-6-PO_4 dehydrogenase*	0·48

The microsomes and soluble fraction were prepared by fractional centrifugation of a homogenate of 200 mgm. of guinea pig liver in five volumes of isotonic potassium chloride. The reaction mixtures contained 500 μmoles of potassium phosphate buffer (*p*H 7·9), 25 μmoles of magnesium chloride, 1 μmole of triphosphopyridine nucleotide, 25 μmoles of nicotinamide, 0·66 μmole of lysergic acid diethylamide, and water to make a final volume of 5·0 ml. Incubation time 120 minutes at 36° in an atmosphere of 95 per cent oxygen and 5 per cent carbon dioxide.

* 2·4 Kornberg units per mgm. of protein (ref. 2).

only traces being excreted in the urine or faeces. Considerable species differences in the rate of metabolism of lysergic acid diethylamide were found. When tissue slice preparations were used, it was observed that only the liver was capable of metabolizing the compound. Further studies at a subcellular level indicated that the transformation of lysergic acid diethylamide was catalysed by enzyme systems present in mammalian liver microsomes when supplemented with oxygen and a reduced triphosphopyridine nucleotide generating system (Table 1). Microsomal enzyme systems requiring triphosphopyridine nucleotide and oxygen have previously been found to catalyse many metabolic reactions[3].

Lysergic acid and *nor*lysergic acid diethylamide, possible metabolic products of lysergic acid diethylamide, were not found after incubation of lysergic acid diethylamide with guinea pig liver microsomal preparations. After extracting the residual lysergic acid diethylamide from the reaction mixture, a butanol-soluble metabolite was found which gave a positive Folin–Ciocalteu reaction[4]. Unlike lysergic acid diethylamide, the metabolite gave no reaction with Hopkins-Cole or Van Urk's dimethylaminobenzaldehyde reagents[5]. These observations suggested that substitution had occurred on position 2 of the indole ring. Since alkaline hydrolysis is known to cleave oxindoles at the amide linkage with the formation of the salt of an amino-acid containing a diazotizable aromatic amino group[6], the lysergic acid diethylamide metabolite was heated at 100° in 2 *N* sodium hydroxide for five minutes and afterwards treated with nitrous acid in acid solution. An intense wine colour appeared when the diazotization mixture was added to an alkaline solution of β-naphthol. These observations indicated that lysergic acid diethylamide was converted to 2-oxy-lysergic acid diethylamide by the microsomal enzyme system dependent on triphosphopyridine nucleotide. Preliminary studies have shown that ergotamine may undergo a similar transformation.

Previous studies have shown that lysergic acid diethylamide blocks synaptic transmission in the lateral geniculate nucleus[7]. An intracarotid administration of 0·4 mgm./kgm. of 2-oxy-lysergic acid diethylamide in nembutalized cats did not alter the postsynaptic response to optic nerve shock, whereas 0·03 mgm./kgm. lysergic acid diethylamide resulted in an 80 per cent decrease in the amplitude of the postsynaptic response. 2-Oxy-lysergic acid diethylamide was also found to be without effect on the spontaneous cortical activity recorded during barbiturate anæsthesia. The oral administration of 300 μgm. of 2-oxy-lysergic acid diethylamide did not produce any psychological effects in human subjects who responded to 30 μgm of lysergic acid diethylamide. It may be concluded on the basis of this evidence that 2-oxy-lysergic acid diethylamide does not show activity like lysergic acid diethylamide in the central nervous system.

Since other investigators have shown biological interactions between lysergic acid diethylamide, serotonin and tranquillizing agents[8], the effect of serotonin, chlorpromazine and reserpine on the metabolism of lysergic acid diethylamide by the microsomal preparation was examined. It was found that chlorpromazine (1×10^{-4} *M*), serotonin (1×10^{-3} *M*) and reserpine (1×10^{-3} *M*) inhibited the enzymatic oxidation of lysergic acid diethylamide 70 per cent, 40 per cent, and 20 per cent, respectively.

A detailed report of these investigations will be published elsewhere.

Julius Axelrod
Roscoe O. Brady
Bernhard Witkop
Edward V. Evarts

National Institutes of Health,
United States Public Health Service,
Bethesda, Maryland. March 14.

[1] Bowman, R. L., Caulfield, P. A., and Udenfriend, S., *Science*, 122, 32 (1955).
[2] Kornberg, A., *J. Biol. Chem.*, **182**, 805 (1950).
[3] Axelrod, J., *J. Pharm. and Exp. Therap.*, **110**, 2 (1954); Axelrod, J., *Fed. Proc.*, **13**, 332 (1954); LaDu, B. W., jun., Gaudette, L., Trousoff, N., and Brodie, B. B., *J. Biol. Chem.*, **214**, 741 (1955); Cooper, J. R., and Brodie, B. B., *J. Pharm. and Exp. Therapy*, **114**, 325 (1955); Axelrod, J., *J. Pharm. and Exp. Therapy*, 115 259 (1955); Axelrod, J., *Biochem. J.* (in the press).
[4] Folin, O., and Ciocalteu, V., *J. Biol. Chem.*, **73**, 627 (1927).
[5] Van Urk, H. W., *Pharm. Weekblad*, **66**, 473 (1929).
[6] Witkop, B., *Ann.*, **558**, 98 (1947).
[7] Evarts, E. V., Landau, W., Freygang, W., jun., and Marshall, W. H., *Amer. J. Physiol.*, **182**, 594 (1955).
[8] Gaddum, J. H., *J. Physiol.*, **121**, 15P (1953); Erspamer, V., *Arch. Internat. Pharmacodyn.*, **10**, 319 (1953); Shore, P. A., Silver, S. L., and Brodie, B. B., *Experientia*, **11**, 272 (1955).

Soil as a Habitat of Vitamin-requiring Bacteria

Most of the B vitamins have been shown to occur in arable soil, their presence being attributable to release from vitamin-containing plant and animal residues, liberation from the roots of growing plants and synthesis by micro-organisms. It is therefore not surprising that bacteria are present for which certain vitamins are essential for growth. It has been previously shown[1,2] that among the indigenous soil bacteria are forms requiring one or more preformed vitamins, while other reports[3,4] have pointed to the need of other types for certain specific factors, namely vitamin B_{12} and the terregens factor. However, apart from a recent report[5] on the incidence of bacteria requiring vitamin B_{12} and the terregens factor in soil and in the rhizosphere of certain plants, no information is available concerning the abundance in soil of bacteria requiring specific vitamins for growth.

A study has been made of the indigenous bacteria of a field soil for which vitamins of the B group were needed for growth, the experiments having been arranged to permit an estimation of the numbers of those requiring specific vitamins. This involved the use of non-selective plating and isolation procedures and determinations of the individual needs of the isolated cultures for the following vitamins by employing suitable vitamin-free basal media: thiamine, biotin, riboflavin, pantothenic acid, nicotinic acid, *p*-aminobenzoic acid, folic acid, vitamin B_{12}, pyridoxin (with pyridoxal and pyridoxamine), choline and inositol.

Table 1

Vitamin required (either alone or with others)	Vitamin-requiring bacteria		
	No. of isolates	Percentage of total isolates	Approximate number per gm. soil
Thiamine (B_1)	96	19·2	10,100,000
Biotin	81	16·2	8,500,000
Vitamin B_{12}	35	7·0	3,700,000
Pantothenic acid	23	4·6	2,400,000
Folic acid	15	3·0	1,600,000
Nicotinic acid	10	2·0	1,000,000
Riboflavin	3	0·6	300,000

Of a total of 499 isolates, 135 or 27·1 per cent (corresponding to 14·1 millions per gm. of soil) required one or more vitamins for growth. The vitamins found to be needed, either alone or with others, are shown in Table 1 in order of frequency. With the great majority of the strains more than one vitamin was required; only in the case of thiamine, biotin and riboflavin were organisms found that needed but a single vitamin. In all, seventeen different 'patterns' were noted for vitamin requirements. For none of the isolates was pyridoxin, *p*-aminobenzoic acid, choline or inositol found to be essential, though in some cases these factors provided stimulation of growth.

Microbial growth-promoting substances and organisms requiring or synthesizing them have received less attention than the subject of microbial antagonisms in soil; yet growth-factor effects could well be as important as antibiotic activity in affecting the microbial equilibrium. The findings reported underline the importance of including growth-promoting substances in any consideration of the microbial economy of soils, whether related to problems of fertility or to those of the interrelationships of the normal soil microflora, plant disease organisms and the plant itself. The results also emphasize the wide diversity of the soil microflora in its nutritional aspects and point to the soil as an important habitat of vitamin-requiring bacteria.

A. G. Lochhead
Margaret O. Burton

Bacteriology Division,
Science Service,
Department of Agriculture,
Ottawa. March 21.

[1] West, P. M., and Lochhead, A. G., *Can. J. Res.*, C, **18**, 129 (1940).
[2] Lochhead, A. G., and Chase, F. E., *Soil Sci.*, **55**, 185 (1943).
[3] Lochhead, A. G., and Thexton, R. H., *J. Bact.*, **63**, 219 (1952).
[4] Lochhead, A. G., and Burton, M. O., *Can. J. Bot.*, **31**, 7 (1953).
[5] Lochhead, A. G., and Burton, M. O., *Soil Sci.* (in the press).

Action of Pepsin on Synthetic Substrates

It has recently been suggested[1] that the apparent first-order kinetics observed in the hydrolysis of certain synthetic substrates (for example, acetyl-L-phenylalanyl-L-tyrosine) by pepsin could be explained if one of the hydrolysis products (acetyl-L-phenylalanine) were only slowly released from the enzyme, as indicated in the following scheme:

$$E + AB \underset{k_2}{\overset{k_1}{\rightleftharpoons}} E.AB \xrightarrow{k_3} EA + B$$

e (total) $\quad s \quad p \quad q$

$$EA \xrightarrow{k_4} E + A$$

where $k_4 < k_3$. (*A*, acetyl-L-phenylalanine; *B*, L-tyrosine. The small letters will be used as symbols for the concentrations of the various species, in the equations which follow.) The reaction-rate was measured by the rate of production of *B* (L-tyrosine amino nitrogen). This scheme would not, however, explain the observed results.

Making the usual steady-state assumptions and putting $K_m = \dfrac{k_2 + k_3}{k_1}$ we have:

$$\frac{ds}{dt} = k_3 p = \frac{k_3(e - q)s}{K_m + s}$$

This equation cannot be integrated directly (contrast ref. 1, equation 22) since q is a function of t. However, in the steady state $k_3 p = k_4 q$. That is, dq/dt, like dp/dt, is so much smaller than ds/dt that it can be neglected except in the initial stages of the reaction.

Therefore, $$q = \frac{k_3 es}{K_m k_4 + (k_3 + k_4)s}$$

and $$p = \frac{k_4 es}{K_m k_4 + (k_3 + k_4)s} = \frac{es}{K_m + \left(1 + \dfrac{k_3}{k_4}\right)s}$$

When $k_3 > k_4$, first-order kinetics will only be observed when $s \ll K_m$. This mechanism cannot explain the observed results, since s was of the same order of magnitude as K_m. It is clear, from the equation for p, that the proposed mechanism will lead to Michaelis–Menten kinetics with apparent k_3 and K_m values that are $k_4/(k_3 + k_4)$ times their true values.

The succeeding communication describes further experiments which provide the correct explanation of the first-order kinetics.

N. M. Green

Department of Biochemistry,
University, Sheffield 10.

[1] Baker, L. E., *J. Biol. Chem.*, **211**, 701 (1954).

In a previous communication[1] regarding the action of pepsin on two of its synthetic substrates, acetyl-L-phenylalanyl-L-tyrosine and N-acetyl-L-tyrosyl-L-tyrosine, results were obtained which seemed to indicate that the products of the hydrolysis were released from the enzyme-substrate complex at different rates, and that it was this phenomenon which accounted for the logarithmic course of the reaction. A communication afterwards received from Dr. N. M. Green showed that the release of the second product at a very slow rate, according to the hypothesis presented, would not lead to a logarithmic course (see accompanying communication by Dr. N. M. Green). A further study of the hydrolysis of acetyl-L-phenylalanyl-L-tyrosine by pepsin was therefore made, and has shown the conclusions that were previously drawn to be incorrect.

Since Haldane[2] has shown that a hydrolysis will follow a logarithmic course when the affinity of one of the products for the enzyme is the same as that of the substrate, experiments on the inhibiting effects of the products were again made. In these experiments it was found that concentrations of acetyl-L-phenylalanine and of the combined products of the hydrolysis which had previously inhibited the hydrolysis of acetyl-L-phenylalanyl-L-tyrosine only 6 per cent now caused 22 per cent inhibition. A search for any differences in technique that might account for these divergent results revealed that in the

experiments previously reported the pepsin that had been used for forming the products had remained with those products until the experiment on their inhibiting effect was made (about 24 hr. later); while in the present experiments the pepsin that had been used for forming the products was heat-killed as soon as they were formed. Also, in the experiments previously made, the acetyl-L-phenylalanine had been mixed with the pepsin on the day before the experiment, just for convenience, and stood in the ice box at *p*H 2·0 until the experiment was made. Tests designed to ascertain if this standing with the pepsin was the cause of the low inhibition that was observed revealed that the combined products of a hydrolysis which caused 21 per cent inhibition if they were used immediately after being formed would produce only 9 per cent inhibition after they had stood overnight at room temperature with pepsin; and acetyl-L-phenylalanine, that caused 22 per cent inhibition before standing with pepsin, caused only 10·3 per cent inhibition after standing overnight at *p*H 2·0 in the ice box.

It is evident from the above that the inhibiting effect of acetyl-L-phenylalanine is much greater than previous results had indicated. To ascertain if its affinity for pepsin was the same as that of the substrate, the velocity constants that would be obtained, if this were so, were calculated from the Haldane equation[2] for a number of different concentrations of this product and the substrate. These were found to agree closely with those obtained experimentally for the same conditions. The logarithmic course of these reactions may therefore be attributed to the fact that the affinity of one of the products for the pepsin is the same as that of the substrate; and not, as was previously supposed, to a difference in the rate at which the two products are released from the enzyme-substrate complex.

Lillian E. Baker
Rockefeller Institute for Medical Research,
New York.

[1] Baker, L. E., *J. Biol. Chem.*, **211**, 701 (1954).
[2] Haldane, J. B. S., "Enzymes", Monographs on Biochemistry, 92 (London and New York, 1930).

Growth of Mouse Tumour in the Chick Embryo with Retention of Capacity by the Chick to form Antibody to the Tumour Cells in Later Life

The development of tolerance to foreign antigens following introduction of these antigens during embryonic life does not necessarily mean that exposure of the embryo *per se* is a sufficient condition for the production of the tolerant state. It appears that the most impressive tolerance has followed the introduction of living homologous cells[1–4], while other types of antigens produce no tolerance or only partial tolerance[5,6]. The possibility exists that the greater effectiveness of the living cells is derived not from their interaction with the embryo alone, but from their persistence in the growing animal over a more prolonged period. If an experimental method existed by which transferred homologous cells could, after a time, be destroyed and the antigens eliminated, this hypothesis could be tested. The following experiment dealing with an analogous situation for heterologous cells is consistent with such a hypothesis.

The Krebs-2 ascites tumour, a highly malignant, uniformly fatal tumour of mice, can be grown in the chick embryo. When we injected a suspension of these cells intravenously into 11-day chick embryos, the tumour cells invaded the chick organs and could regularly be found growing in the embryonic liver, brain or heart in the form of separate islands, each presumably arising from a single injected cell. On about the seventeenth day of incubation, the tumour cells began to degenerate and the tumour areas became infiltrated with eosinophilic cells. By the time of hatching (twenty-first day) the tumour was generally eliminated and the birds could be raised to maturity in a tumour-free state. (The reason for the general failure of the tumour cells to survive in embryos is not clear and is the subject of continuing investigation. In some cases the tumour is not eliminated, but instead kills the chick, either in embryonic life, or shortly after hatching. The destruction around the eighteenth day of incubation of foreign tissue cultivated on the chorio-allantoic membrane of the chick embryo has been attributed to an immune reaction[7]. However, in the absence of any direct demonstration of antibody in chick embryos this interpretation remains in doubt.) Such birds were shown to possess the capacity to form antibody to the tumour.

Forty-three chick embryos on their eleventh day of incubation were injected with 0·04 ml. of a 1 : 100 dilution of mouse ascitic fluid which contained about 10^8 tumour cells per ml. Incubation of the embryos was continued together with sixteen non-injected controls. Of those injected, nineteen died within 48 hr., presumably from tumour cell emboli; of the remainder, nine selected at random were killed during the sixteenth to eighteenth days of incubation, and their livers, brains and hearts were examined in microscopic section. A portion of the liver of each of the embryos killed on the seventeenth and eighteenth days was crudely minced and injected intraperitoneally into two mice. Of the embryos examined, all but one contained living tumour in their organs. In some embryos, roughly 2 per cent of all cells in the liver were found to be tumour cells. In all cases in which tumour cells were seen microscopically in liver sections, transfer of liver mince to mice was followed by the development of typical ascites tumour.

Eight of the embryos injected with tumour and eight controls hatched and lived through to adulthood. At first the injected chicks were somewhat smaller and less vigorous than the controls; but by the age of one month these differences had disappeared. The sera of the birds were tested periodically for their ability to agglutinate a standard suspension of washed ascites tumour cells (0·25 ml. diluted serum plus 0·05 ml. of 1·5 per cent cell suspension read after 20 min. in Kahn shaker at room temperature). No antibodies were detectable until the age of five weeks, when low-titre agglutinins begin to appear in normal chickens. At this time the birds were divided into two groups, *A* and *B*, each consisting of four injected and four control animals. The members of group *A* were injected periodically with the washed cells from 0·2 ml. of ascites fluid while those of group *B* were not.

In Fig. 1 are shown the resulting serum dilution titres for agglutinins against a standard suspension of ascites cells. In group *A*, each pair of points was preceded one week earlier by the immunizing injections of ascites cells. These animals showed strong specific antibody responses whether or not they had contained growing tumour cells during their embryonic life. The small difference shown between chicks of

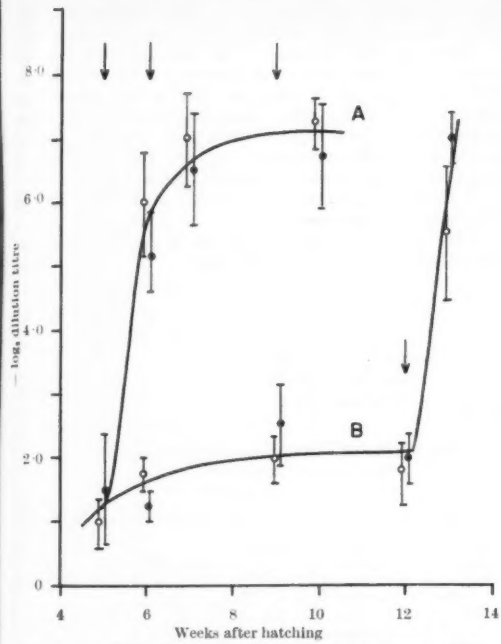


Fig. 1. •, Chicks from tumour-injected embryos; ○, chicks from uninjected embryos. Each point is the mean of four birds (range indicates standard error). ↓, Intraperitoneal injection of washed cells from 0·2 ml. of ascitic fluid

the two classes is not statistically significant. Group *B* animals of both classes developed only low-titre agglutinins until the age of twelve weeks, when a single injection of tumour cells resulted in a sharp rise in titre in all animals.

It is clear from these experiments that the presence of foreign cells growing in an animal during its embryonic life is not in itself a sufficient condition for the production of a state of permanent tolerance to the cellular antigens. In the case of tolerance following the introduction of homologous cells, permanent survival of the cells could result not only in persistence of the antigens involved but also in great increase in their amount. Such cells might liberate antigen over the period of maturation of the animal, producing a type of tolerance not fundamentally different from the condition produced postnatally in rabbits[8–10] by the administration of simple antigens.

HOWARD GREEN
ALLAN L. LORINCZ

Departments of Immunochemistry and Dermatology,
Walter Reed Army Institute of Research,
Washington 12, D.C.
May 20.

[1] Owen, R. D., *Science*, **102**, 400 (1945). Billingham, R. E., Lampkin, G. H., Medawar, P. B., and Williams, H. Ll., *Heredity*, **6**, 201 (1952).
[2] Billingham, R. E., Brent, L., and Medawar, P. B., *Nature*, **172**, 603 (1953); *Phil. Trans. Roy. Soc.*, B, **239**, 357 (1956).
[3] Hasek, M., *Ceskoslov. Biol.*, **3**, 327 (1954).
[4] Koprowski, H., *Nature*, **175**, 1087 (1955).
[5] Burnet, F. M., Stone, J. D., and Edney, M., *Aust. J. Exp. Biol. Med. Sci.*, **28**, 291 (1950).
[6] Buxton, A., *J. Gen. Microbiol.*, **10**, 398 (1954).
[7] Murphy, J. B., *J. Exp. Med.*, **19**, 513 (1914).
[8] Hanan, R., and Oyama, J., *J. Immunol.*, **73**, 49 (1954).
[9] Dixon, F. J., and Maurer, P. H., *J. Exp. Med.*, **101**, 245 (1955).
[10] Cinader, B., and Dubert, J. M., *Brit. J. Exp. Path.*, **36**, 515 (1955).

Resting Tension in Snail Muscle

WHEN weighted with even a very small load, the smooth retractor of the snail's pharynx extends to great lengths[1]. This phenomenon has been taken to indicate an almost complete absence of elastic material in parallel with the fibres of that muscle[2]. In connexion with work to be published elsewhere, we have been able to show that the snail muscle actually has a parallel elastic component which produces resting tension at appropriate lengths.

It is well known that above a length which coincides with that at which maximum isometric tension is developed, frog sartorius muscle exerts a resting tension[3]. We find that precisely the same is true of the snail muscle. Maximum isometric tension is produced at about 40 mm. and decreases on either side of that length (upper curve, Fig. 1). Resting tension appears at any lengths greater than the optimum length for isometric tension (lower curve, Fig. 1). But in comparison with its own maximum isometric tension or with the resting tension exerted by frog sartorius, the highest value for the resting tension of the snail muscle is small. This is explained by the dimensions of the snail muscle: it weighs only 30–40 mgm. and at a length of about 50 mm. its cross-section is very small. Although at such a length the active muscle develops tension of the order of 20 gm., the resting muscle may tear at approximately 8 gm.—a breaking stress of 1·5 kgm./cm.^{2}, which points to the presence of a reasonable amount of parallel elastic material.

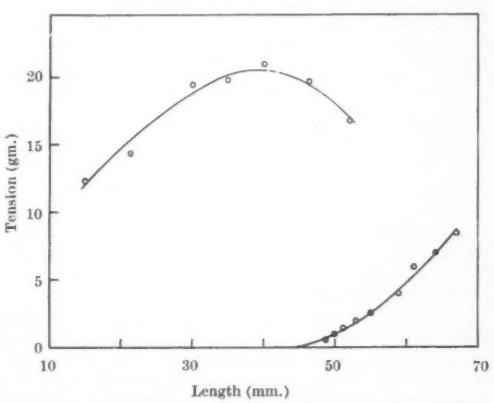


Fig. 1. Tension–length diagram of the pharynx retractor muscle of *Helix* at 14° C., during isometric contraction (upper curve) and at rest (lower curve)

The length–tension curve during isometric contraction in Fig. 1 also shows that the snail muscle can still produce appreciable tension down to lengths less than 12 mm. (30 per cent of its optimum length). It thus has a remarkably wide working range: frog sartorius at the equivalent short length develops no active tension at all[3]. The wide working range of the snail muscle probably explains why the existence of its resting tension has not been hitherto clearly demonstrated.

We conclude that snail muscle (and most likely other types of smooth muscle) can exert resting tension at appropriate lengths. This, together with evidence we have obtained from studies of tension changes resulting from quick stretch of resting muscle, force–velocity relations of active muscle,

and shortening heat production, strengthens the view that the mechanical properties of smooth and striated muscle do not differ fundamentally.

B. C. Abbott
J. Lowy

Marine Biological Laboratory,
Plymouth, and
Department of Zoology,
University of Belfast.
March 10.

[1] Bozler, E., *Z. vergl. Physiol.*, **12**, 579 (1930).
[2] Hill, A. V., *Nature*, **166**, 415 (1950).
[3] Aubert, X., Roquet, M. L., and van der Elst, J., *Arch. Int. Physiol.*, **59**, 239 (1951).

Experimental Maturation or Ageing of Collagen in Rabbits' Ears

In the course of a study of direct connective tissue changes, observations were made which have a bearing on the problem of ageing of collagen.

Rabbits' ears were subjected to rhythmical stretching and relaxing movements (20,000–80,000) by mechanical means. Histological examination revealed a thickening of the collagen fibres which were more wavy, crinkled and often fragmented. Although the spaces between the loosened fibres in the stretched ears were larger and more numerous than in the controls, the general appearance was that of a greater homogeneity of the whole corium. A cellular infiltration and in particular an increase in the number of fusiform, that is, mature, fibroblasts were noticeable.

The most interesting finding, however, was that of 'clearing' or 'dispersal' of the amorphous ground-substance coating of the fibrils seen on the electron microscope photographs. A count of individual fibrils in five classes, into which they were divided according to the lesser or greater amount of coating material which allowed the unaltered periodicity of cross-striation of individual fibrils to be distinguished, or obscured it in varying degrees, showed a shift towards a distribution found in aged tissues.

A decrease, with increasing age, in the amount of the amorphous substance coating the fibrils in other tissues has been reported[1–3].

Our findings indirectly confirm those of Angevine[4], who found in his histological preparations that when a stress or tension is exerted on the rabbit's ear by pulling, there is a mechanical stimulation of fibroblasts; they form in greater abundance, and the direction of stress determines the direction in which they are distributed. Banfield[5] found that the extractability with acetic acid of collagen from human skin, tendon and dura varied with age. Similarly the swelling of human Achilles tendon in acetic acid decreased as age increased.

Other alterations in the properties of collagen variable with age were found by Verzár[6]. The tendons of the tails of white rats show after the fifth month a thermo-elastic contraction which increases progressively with ageing. Similarly the skin shows an increasing thermo-elastic contraction after the third month.

Disregarding the mechanical effects, it is reasonable to assume that thermal and *p*H changes—though probably on a small scale—have taken place in the stretched ears. The underlying morphological changes brought out in the histological and electron microscope studies in our series may belong to the same category of events as those occurring with thermal and chemical contraction[7,8]. The degree of these may depend on the degree of the stimulus applied.

Although the nature of the coating material, its dissolving or removal or translocation are all matters of conjecture, it is thought that a correlation of changes occurring after thermal, chemical or other stimuli, with the connective tissue changes in our series due to experimental wear and tear, may throw some light on processes underlying ageing.

A detailed account of the method and results will be published elsewhere.

This work was supported by a grant from the British Empire Cancer Campaign.

B. Jolles
S. G. Greening
G. B. Dun

Department of Radiotherapy,
General Hospital,
Northampton.

Pamela Tymms

Department of Experimental Pathology
and Cancer Research,
University of Leeds.

[1] Ragan, C., Trans. 1st Conference on Connective Tissues, Josiah Macy Jr. Foundation, p. 23 (1950).
[2] Gross, J., *J. Gerontol.*, **7**, 584 (1952).
[3] Eaves, G., Thesis for Ph.D., Univ. of Leeds (1953).
[4] Angevine, M., Trans. 1st Conference on Connective Tissues, Josiah Macy Jr. Foundation, p. 18 (1950).
[5] Banfield, W. G., *Anat. Rec.*, **114**, 157 (1952).
[6] Verzár, F., *Experientia*, **11**, 230 (1955).
[7] Banga, I., *Nature*, **172**, 1099 (1953).
[8] Banga, I., Baló, J., and Szabó, D., *Nature*, **174**, 788 (1954).

Effect of Molybdenum Deficiency on Catalase and Peroxidase in *Neurospora*

Molybdenum has been identified as a constituent of nitrate reductase in some bacteria[1], fungi[2–4] and higher plants[5], and the micro-nutrient was shown to undergo a valence change involving Mo^{6+} and Mo^{5+} during the enzymatic reduction of nitrate[6]. Apart from its role in nitrate reductase, it is known that molybdenum is also important for other metabolic processes in plants. When ammonium is the sole source of nitrogen, nitrate reductase does not usually form in plants, and the molybdenum requirement, although considerably reduced, is not completely eliminated.

In this communication it is shown that a deficiency of molybdenum in *Neurospora crassa* reduced the catalase and peroxidase enzymes in cell-free extracts of the felts by 1/10 and 1/4 respectively of that in normal tissues.

Neurospora crassa wild type 146 (microconidial type) was grown in a modified Fries medium containing ammonium nitrate as the source of nitrogen[2]. The removal of molybdenum from the basal culture solution was achieved by the copper coprecipitation methods[7]; molybdenum (20 μgm. per litre) was then added back to some of the purified culture media which served as controls. The media were dispensed in 200-ml. amounts in 1-litre Erlenmeyer flasks, inoculated with a spore suspension of the fungus contained in triple-distilled water, and incubated for four days in the dark at 28° C. The mycelial mats from the normal and molybdenum-deficient cultures were collected separately in a Büchner funnel, washed well with triple-distilled water, and frozen for 1–3 hr. at − 15° C. They were ground with a cold pestle

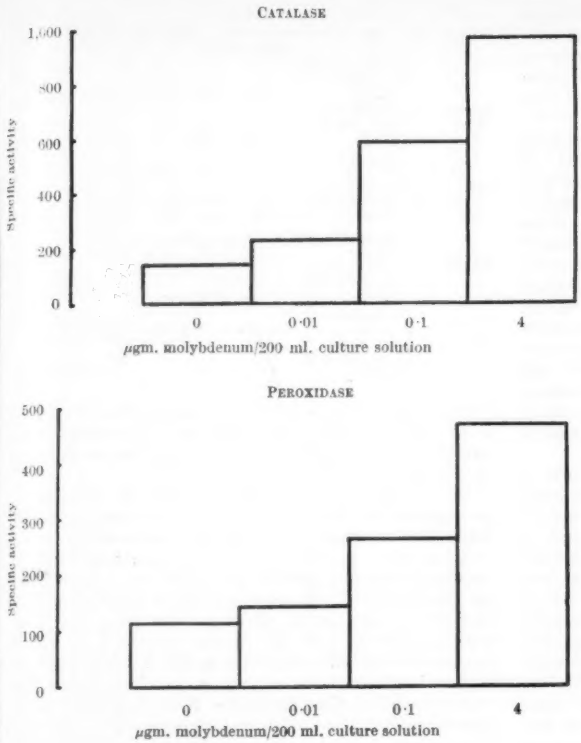


Fig. 1

and mortar with three times their weight of cold 0·1 *M* phosphate buffer (*p*H 7·5) and then in a TenBroeck glass macerater. The solutions were centrifuged at 2,000 *g* for 10 min. at 4°.

The protein contents of the extracts were determined by Lowry's method[8]. Catalase was determined in aliquots of the extracts by the perborate method[9] and the enzyme activity is expressed as μmoles perborate degraded in 5 min. per mgm. protein. The peroxidase was determined by the method of Smith *et al.*, as the change in log I_0/I_1 of 0·001 per minute calculated from 15 to 75 sec. per mgm. protein[10].

Molybdenum deficiency in *Neurospora* resulted in a 40–55 per cent reduction in growth. The effects of the deficiency on the two iron enzymes are shown in Table 1.

A deficiency of molybdenum in *Neurospora* significantly reduced the two iron enzymes; the effect on catalase is more severe than for peroxidase.

Table 1. EFFECT OF MOLYBDENUM DEFICIENCY ON CATALASE AND PEROXIDASE IN *N. crassa*

Enzyme	Expt.	+Mo	−Mo	Reduction: as per cent of controls
Catalase	1	640	193	30
	2	732	158	22
	3	756	83	11
Peroxidase	1	330	134	40
	2	138	63	45

+Mo cultures contained 20 μgm. molybdenum per litre. Enzyme units given in text.

In Fig. 1 are shown the effects of adding graded amounts of molybdenum to the basal culture solution on the two enzymes present in cell-free extracts of the felts. Increasing the molybdenum content of the medium is paralleled by increases in the two enzymes; the maximum activity is reached when 4 μgm. molybdenum is given per 200 ml. culture solution.

When molybdenum was added aseptically *in vivo* to the omit-molybdenum cultures after three or four days growth, the two enzymes were adapted to the added micronutrient and were reconstituted within 24 hr. to about 70 per cent of those in the control cultures. It was not possible to reconstitute the two enzymes by adding 0·1 μgm. or 1 μgm. of molybdenum to homogenates of the molybdenum-deficient felts. Mixing extracts of normal with those of molybdenum-deficient felts proved that there was neither an inhibitor in the deficient felts nor an activator in the normal ones.

Whether molybdenum is a constituent of the iron enzymes or whether the effect is an indirect one is as yet unknown. It is established that molybdenum deficiency results in a reduction in certain flavoprotein enzymes which produce hydrogen peroxide[11]. A deficiency of the micronutrient could therefore result in a low production of hydrogen peroxide in the fungus so that catalase and peroxidase, which are known to be adaptive enzymes, would thus be depleted. Experiments now in progress may elucidate the role of molybdenum in relation to the two iron enzymes.

D. J. D. NICHOLAS

Agricultural Research Council
Unit of Plant Nutrition (Micronutrients),
Long Ashton Research Station,
University of Bristol. March 22.

[1] Nicholas, D. J. D., and Nason, A., *J. Bact.*, **69**, 5, 58 (1955).
[2] Nicholas, D. J. D., Nason, A., and McElroy, W. D., *J. Biol. Chem.*, **207**, 341 (1954).
[3] Nicholas, D. J. D., and Nason, A., *J. Biol. Chem.*, **207**, 353 (1954).
[4] Nicholas, D. J. D., and Nason, A., *J. Biol. Chem.*, **211**, 183 (1954).
[5] Nicholas, D. J. D., and Nason, A., *Plant Phys.*, **30**, 135 (1955).
[6] Nicholas, D. J. D., and Stevens, H. M., *Nature*, **176**, 1066 (1955).
[7] Nicholas, D. J. D., *Analyst*, **77**, 629 (1952).
[8] Lowry, O. H., Rosebrough, N. I., Farr, A. L., and Randall, R. J., *J. Biol. Chem.*, **193**, 265 (1951).
[9] Feinstein, R. N., *J. Biol. Chem.*, **180**, 1197 (1949).
[10] Smith, F. G., Robinson, W. B., and Stotz, E., *J. Biol. Chem.*, **179**, 881 (1949).
[11] Lenhoff, H. M., Nicholas, D. J. D., and Kaplan, N. O., *J. Biol. Chem.*, (in the press).

Cumulative Effect of Sub-Lethal Doses of Insecticides on Houseflies

THE effectiveness of repeated small doses of insecticides is of considerable practical importance. For example, mosquitoes and houseflies entering houses treated with residual insecticides make intermittent contacts with deposits, and tsetse flies may receive a succession of doses when applications of insecticides are made from aircraft on a number of parallel runs in each day's sortie, and the area treated at the end of one sortie is re-treated at the beginning of the next. Hoffmann *et al.*[1] exposed houseflies intermittently to small amounts of DDT residues

and found that the longer the intervals between exposures the greater the number of flies that survived. There is, however, little quantitative information, and the experiments summarized below were designed to determine the cumulative effect of sublethal doses of insecticides on houseflies.

Flies for the experiments were taken from a normal laboratory colony with no previous experience of insecticides. Females only were used; they are less susceptible than males, and although their susceptibility decreases during the first four days after emergence it remains fairly constant for the next week or more. Small measured volumes of each insecticide solution were applied to the dorsal surface of the thorax of individual flies from a microburette similar to that described by Kerr[2]. The concentration of each insecticide in kerosene (0·25 per cent gamma-BHC, 1 per cent DDT, 0·07 per cent dieldrin, and 0·25 per cent 'Diazinon') was selected so that a range of kills for the calculation of the *LD*50 was obtained with volumes of 0·029–0·058 µl. Breeding, treatment and storage after treatment were all at 25° C.

In the first series of experiments, the volumes of insecticide solutions were applied in two equal doses with an interval of 0, 24 and 48 hr. between them. Other batches of flies from the same culture and of the same age were given the two doses on the second and third day of each experiment to check variation in susceptibility with age. Results of one series of experiments are summarized in Table 1; repeat experiments provided essentially the same results. The two doses of DDT, dieldrin and 'Diazinon' were fully cumulative even with an interval of 48 hr. between the application of the first and second dose, whereas when 24 or 48 hr. elapsed between the application of the first and second dose of gamma-BHC, mortalities were significantly lower than when the two doses were applied one immediately after the other. It would appear that approximately 50 per cent of the first dose had been rendered ineffective by the time the second dose was applied 24 or 48 hr. later.

In the second series of experiments smaller volumes of 0·009 µl. of each insecticide solution were applied daily to individual flies, and variation in susceptibility with age was checked by treatment of other batches of flies from the same culture on various days. Results of one set of experiments are summarized in Table 2, and are similar to those obtained on other occasions.

When mortality counts had been made 24 hr. after the application of the sixth daily dose of gamma-BHC, survivors from the various replicates were pooled and then divided at random into batches. Different doses of gamma-BHC were applied to each batch and the *LD*50 determined. The survivors had an *LD*50 of 0·075 µgm. gamma-BHC per fly (ignoring the six daily doses) compared with 0·094 µgm. for untreated flies of the same age from the same culture. In the same way it was found that the survivors from the six daily doses of DDT had an *LD*50 of 0·15 µgm. DDT per fly (again ignoring the daily doses) compared with 0·39 µgm. for untreated flies of the same age from the same culture.

Table 1

Age of flies at first dose	Time interval between the two doses	*LD*50, µgm. insecticide per fly			
		Gamma-BHC	DDT	Dieldrin	'Diazinon'
4–5 days	48 hr.	0·148	0·492	0·028	0·100
4–5 ,,	24 ,,	0·146	0·465	—	—
4–5 ,,	0 ,,	0·104	0·450	0·027	0·103
5–6 ,,	0 ,,	0·112	0·486	—	—
6–7 ,,	0 ,,	0·101	0·475	0·028	0·098

Table 2

Dosages are in µgm. insecticide per fly; *LD*50's are for flies from the same culture

	Age of flies (days)	3–4	4–5	5–6	6–7	7–8	8–9
Gamma-BHC	Cumulative dosage	0·023	0·045	0·068	0·090	0·113	0·135
	Cumulative per cent kill	0	0	0	0	1	1
	*LD*50	0·092	0·105	—	—	—	0·092
DDT	Cumulative dosage	0·09	0·18	0·27	0·36	0·45	0·54
	Cumulative per cent kill	0	0	1	1	11	20
	*LD*50	0·32	0·40	—	—	—	0·39
Dieldrin	Cumulative dosage	0·006	0·013	0·019	0·025	0·032	
	Cumulative per cent kill	0	0	2	16	42	
	*LD*50	0·022	0·027	—	—	0·024	
'Diazinon'	Cumulative dosage	0·023	0·045	0·068	0·090	0·113	
	Cumulative per cent kill	0	0	4	20	60	
	*LD*50	0·087	0·100	—	—	0·094	

In no case were the daily doses of one-fifth to one-quarter of the *LD*50 fully cumulative; but the degree of tolerance for the four insecticides varied considerably, being lowest for 'Diazinon' and increasing through dieldrin and DDT to a high value for gamma-BHC. In fact, the doses of gamma-BHC had little cumulative effect; kills after six doses were negligible, and the dosage required to kill 50 per cent of the survivors was nearly as much as that required to kill the same proportion of untreated flies.

It is evident that houseflies from a normal strain have the ability to eliminate, metabolize or store in a harmless condition, to a greater or lesser extent depending on the insecticide, a proportion of the absorbed insecticide provided that the dosage is sufficiently low. The results of these experiments appear to substantiate biologically the biochemical findings of Perry and Hoskins[3] that susceptible, as well as DDT-resistant, flies are able to detoxify DDT, and those of Oppenoorth[4] and Bradbury and Standen[5] that susceptible flies can rapidly metabolize gamma-BHC. The significance of this ability of normal flies to metabolize insecticides in relation to the development of resistance, however, must be determined by further research.

A. B. Hadaway

Colonial Insecticides Research Unit,
Porton, Wilts.
March 8.

[1] Hoffmann, R. A., Roth, A. R., and Lindquist, A. W., *J. Econ. Ent.*, **44**, 734 (1951).
[2] Kerr, R. W., *Bull. Ent. Res.*, **45**, 317 (1954).
[3] Perry, A. S., and Hoskins, W. M., *J. Econ. Ent.*, **44**, 850 (1951).
[4] Oppenoorth, F. J., *Nature*, **173**, 1000 (1954).
[5] Bradbury, F. R., and Standen, H., *J. Sci. Food Agric.*, **6**, 90 (1955).

Interspecific Competition in Higher Plants

The results of experiments on interspecific competition between vegetable crops and annual weeds suggest that a relationship exists between the crop weight and weed weight per unit area when the relative density of the two species is varied. The relationship appears to be of the type:

$$(X - Xo)(Y - Yo) = C \qquad (1)$$

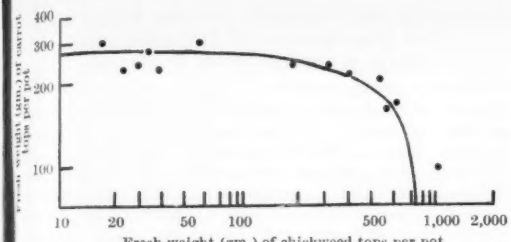


Fig. 1. Fitted curve: $(x - 3{\cdot}10)(y - 2{\cdot}45) = 0{\cdot}054$

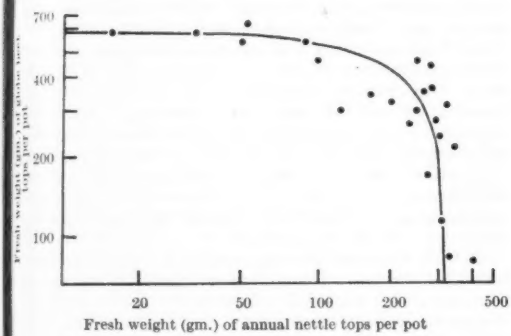


Fig. 2. Fitted curve: $(x - 2{\cdot}53)(y - 2{\cdot}82) = 0{\cdot}27$

where Xo and Yo are the logarithms of the yields of given numbers of plants of species A and B respectively, grown separately in a given area, and X and Y are the logarithms of the corresponding yields when the two species are grown together in the same area. The value of C will depend upon the two species concerned and the environment.

Fig. 1 illustrates the relationship obtained in a pot experiment on competition between carrot and chickweed (*Stellaria media* (L.) Vill.). The carrot stand was the same in each pot and the seed was sown on one date. The various weed weights were obtained by varying the weed density or the sowing date. The manner in which the various weed weights were obtained has not obviously affected the relationship. In another experiment three densities of globe beet were used, all sown at one date, and one density of annual nettle (*Urtica urens* L.) sown on two dates (at crop sowing and crop germination). Fig. 2 illustrates the results obtained.

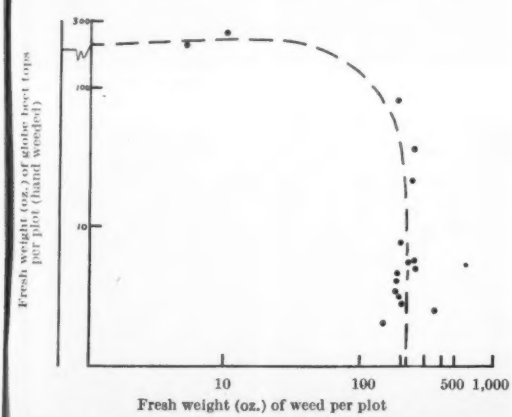


Fig. 3. Possible curve of hyperbolic type, drawn in by eye

A field experiment with a naturally dispersed and mixed weed population and a crop of globe beet grown in rows yielded results which tend to confirm the results of the pot experiments. However, the absence of values in the region of maximum curvature of the graph plotted in Fig. 3 does not allow a detailed study of the trend. The various weed weights were obtained by reducing the natural weed population by applications of a contact pre-emergence herbicide at different rates.

The results presented by Mann and Barnes[1] in a series of papers on the competition between barley and certain weeds and between rye-grass and clover may be plotted to show that the relationship between the logarithms of the weights per unit area of species A and B can be adequately described by a curve of type (1).

The practical point of interest is the amount of weed a crop can tolerate before competition starts. Preliminary results suggest that the weight of weed in a crop is linearly related to the percentage cover of the weed (at least over a considerable range of cover). It is hoped that cover assessments, which are non-destructive and easily obtained, may prove useful in determining the time of onset of competition. Such information could then be used for assessing the best time to apply weed control measures and to evaluate present weed control practice.

I am indebted to Mr. H. A. Roberts for his co-operation in the field experiment described, and to Mr. J. A. Nelder for his help with the mathematical aspects of this communication.

J. K. A. Bleasdale

National Vegetable Research Station,
Wellesbourne,
Warwick.
Feb. 16.

[1] Mann, H. H., and Barnes, T. W., *Ann. App. Biol.*, **32**, 15 (1945); **34**, 252 (1947); **36**, 273 (1949); **37**, 139 (1950); **39**, 111 (1952); **40**, 566 (1953)

Toxicity and Breakdown of 'Hormone' Herbicides

During the course of an investigation of the effect of certain 'hormone' herbicides, when applied to the rooting medium, on the growth and nodulation of white clover (*Trifolium repens*), some interesting features emerged on the relative toxicities of these compounds. The substances utilized were the sodium salts of 24*D* (2 : 4-dichlorophenoxyacetic acid), *MCPA* (2-methyl-4-chlorophenoxyacetic acid), 245*T* (2 : 4 : 5-trichlorophenoxyacetic acid), 24*DB* (γ-(2 : 4-dichlorophenoxy)butyric acid) and *MCPB* (γ-(2-methyl-4-chlorophenoxy)butyric acid). Their action on the white clover was determined by growing the plants in (*a*) aseptic agar culture in test-tubes and (*b*) soil culture in pots. The agar rooting medium was the nitrogen-free formula described by Thornton[1] and the soil was John Innes compost which had been allowed to weather for a year in the open air. The plants were inoculated with a known effective strain of *Rhizobium trifolii*. The hormone substances were incorporated in the agar in the appropriate concentrations. In the case of the pot experiment, the soil was air-dried, and 100 c.c. of the chemical at the appropriate

Table 1. Effect of Hormone Herbicides on the Nodulation and Growth of *T. repens*

Each reading is the average of seven tubes

Tube Experiment

Substance	Length of root (mm.) (a)	Length of root (mm.) (b)	No. of nodules (a)	No. of nodules (b)	Total dry wt. of plants (mgm.) (a)	Total dry wt. of plants (mgm.) (b)
24*D*	65	38	3	0	4	1
MCPA	238	33	9	0	11	1
245*T*	529	55	15	1	35	2
MCPB	1,009	282	19	12	35	18
24*DB*	1,009	1,056	33	17	45	34
Control (inoc.)	1,283	1,283	35	35	47	47
Control (uninoc.)	601	601	0	0	3	3

(*a*) Concentration 0·1 p.p.m. (acid equivalent).
(*b*) Concentration 1·0 p.p.m. (acid equivalent).

Each reading is the average of seven pots

Soil Experiment

Substance	No. of plants harvested (a)	No. of plants harvested (b)	No. of nodules (a)	No. of nodules (b)	Wt. of nodules (mgm.) (a)	Wt. of nodules (mgm.) (b)	Dry wt. of plants (mgm.) (a)	Dry wt. of plants (mgm.) (b)
245*T*	8	0	52	0	4	0	235	0
MCPA	13	7	188	43	7	2	481	111
MCPB	14	9	132	76	5	4	499	295
24*D*	23	22	285	222	16	11	1,238	1,123
24*DB*	21	22	348	384	16	20	1,518	1,802
Control	22	22	305	305	18	18	1,359	1,359

(*a*) Concentration 5·0 p.p.m. (acid equivalent).
(*b*) Concentration 12·0 p.p.m. (acid equivalent).

concentration was added to each pot containing 175 gm. of soil. Each pot was stood in a Petri dish of water to eliminate the effects of leaching. There were seven tubes and seven pots per treatment.

The plants were grown for ten weeks in a cool greenhouse and then harvested. The results are shown in Table 1.

From Table 1 it is clear that in the tube experiment the order of toxicity is (1) 24*D* most toxic, (2) *MCPA*, (3) 245*T*, (4) *MCPB*, and (5) 24*DB* least toxic. This may be looked upon as a measure of their true toxicity. In the soil, however, the order of toxicity is (1) 245*T*, most toxic, (2) *MCPA*, (3) *MCPB*, (4) 24*D*, and (5) 24*DB* least toxic.

From the tube experiment it can be seen that 245*T* in itself is not more toxic than 24*D* or *MCPA*. It is postulated that 245*T* owes its greater effectiveness in soil to its greater persistence there. Similarly, *MCPA* lasts[2] much longer in the soil than 24*D* and it therefore is much more effective.

The toxicity of the *MCPB* in the soil may be attributed to its breakdown in the soil to *MCPA* by micro-organisms possessing the β-oxidizing system. The possibility of such a breakdown has already been mentioned by Wain[3]. The relative ineffectiveness of 24*DB* may be attributed to its breakdown by similar organisms to 24*D*, which is afterwards rapidly rendered innocuous by other soil micro-organisms.

Our thanks are due to Messrs. May and Baker who supplied the 24*DB* and *MCPB* for experimental purposes. It is hoped that these experiments will be published in more detail elsewhere.

Wm. W. Fletcher
John C. Raymond
West of Scotland Agricultural College,
Glasgow.
Feb. 11.

[1] Thornton, H. G., Imp. Bur. Soil Sci. Tech. Comm. 20 (1931).
[2] Audus, L. J., "Plant Growth Substances" (Leonard Hill, Ltd., London, 1953).
[3] Wain, R. L., *Agric. Rev.*, **1**, 1 (1955).

Impression Methods for the Study of the Distribution of Deposits and Organisms on Plant Surfaces

The use of transmitted illumination in microscopic studies of chemical or biological material on plant surfaces is limited by the opaqueness of the plant tissues. The methods described by Crisp and Thorpe[1] and Bryson[2] for obtaining transparent impressions of various surfaces in gelatin and cellulose acetate respectively have been successfully applied to the study of deposits on leaf surfaces. Such impressions can be readily enlarged and examined visually or photographically; simple 35-mm. projection provides ample magnification for general distribution studies of materials on plants, but for more detailed studies much higher magnification can be used.

Leaf impressions are obtained by pressing the leaf to be examined on to a cellulose acetate film (0·005 in. thick) previously moistened with a 5·0 per cent solution of cellulose acetate in acetone. When the impression has hardened (approx. 60 sec.) the leaf is carefully peeled off. In a similar manner gelatin impressions may be obtained on a glass slide coated with a warm solution of gelatin in water in approximately equal proportions. These impressions may take up to 30 min. to set hard.

By one or other of these methods it is possible to examine almost all solid spray deposits on plant material. Since many of the organic insecticides and fungicides are soluble in acetone the cellulose acetate method cannot be used to detect such materials, while for similar reasons gelatin is not suitable for water-soluble deposits. A gelatin impression (Fig. 1) illustrates a deposit of BHC crystals on the upper surface of a broad-bean leaf; these crystals are relatively large, but the distribution of crystals of the order of 1·0μ has been studied by this method.

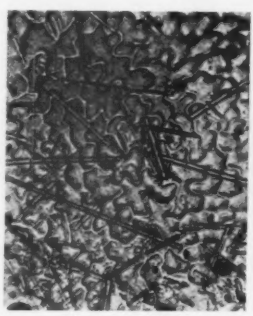


Fig. 1. (× 82·5)

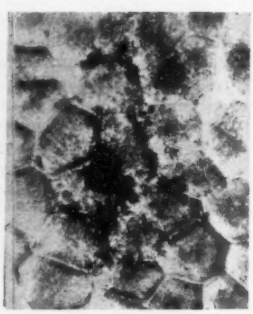


Fig. 2. (× 115)

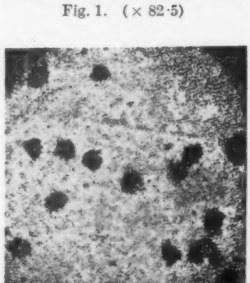


Fig. 3. (×17·5)

Fig. 4. (× 185)

Spray deposits of copper and lime sulphur are neither crystalline nor strongly coloured, and for these reasons are not clearly distinguishable in an impression. They are, however, completely removed on to the surface of a cellulose acetate impression and may be developed by treating the impression with a suitable solution which converts the deposit into a more highly coloured compound. Thus a solution of sodium diethyldithiocarbamate converts copper to a dark brown complex and lead acetate solution produces a black deposit of lead sulphide from lime sulphur. Fig. 2 is a high-power photomicrograph showing the distribution of copper from a single spray droplet (approximately 100μ diameter) of Bordeaux mixture on the upper surface of a cyclamen leaf. The particles of copper fungicide have collected in the cuticular depressions at the edges of the epidermal cells. Fig. 3 is a low-power photomicrograph of the deposit produced by discrete drops of 32 per cent lime sulphur on the upper surface of a broad-bean leaf, and it demonstrates the value of the method in rapidly assessing the macroscopic distribution of spray deposits. The use of the methods is not restricted to leaves, but on other surfaces, such as fruit or bark, difficulty may be experienced in applying even pressure to a sufficiently large area. In such cases a satisfactory method is to remove strips of the surface before impressing them.

The method may also be used for studying the distribution and development of fungus spores, which are removed in a cellulose acetate impression of a leaf surface and can be stained with a suitable dye as illustrated in Fig. 4, which shows the distribution of germinating spores of *Botrytis fabae* stained with saffranin on a broad-bean leaf. The method is very useful in studying the range of action of fungicides, since a single impression can show both spore development and the distribution of the fungicide. Population studies of small animals such as mites on plants can be made; all stages of the mites are removed from the leaf surface in cellulose acetate and are easily distinguishable under simple projection.

S. H. Bennett
C. G. L. Furmidge

Research Station, Long Ashton,
Bristol. March 13.

[1] Crisp, D. J., and Thorpe, W. H., *Nature*, **165**, 273 (1950).
[2] Bryson, H. Courtney, *Lab. Practice*, **3**, 377 (1954).

Lack of Christmas Factor in Horse Plasma

Bell, Archer and Tomlin[1], using the thromboplastin generation test, recently found the prolonged clotting time of horse blood to be due to a deficiency of anti-hæmophilic factor. However, Soulier and Larrieu[2] have used horse plasma as a source of this factor. The thrombin generation test[3,4] is useful in differentiating between classical hæmophilia and Christmas disease[5]. Applied to citrated horse plasma (containing 130,000 platelets per c.mm.) the following results were obtained (Fig. 1).

Curve *A* shows the thrombin generation in 1 ml. normal horse plasma. The addition of 0·2 ml. plasma from a patient with Christmas disease did not improve the results (curve *B*). Addition of normal human serum (curve *C*) made the thrombin generation normal, whereas barium sulphate absorbed normal human plasma without effect (curve *D*). After the addition of 0·2 ml. plasma from a patient with classical hæmophilia (AHF deficiency) the thrombin

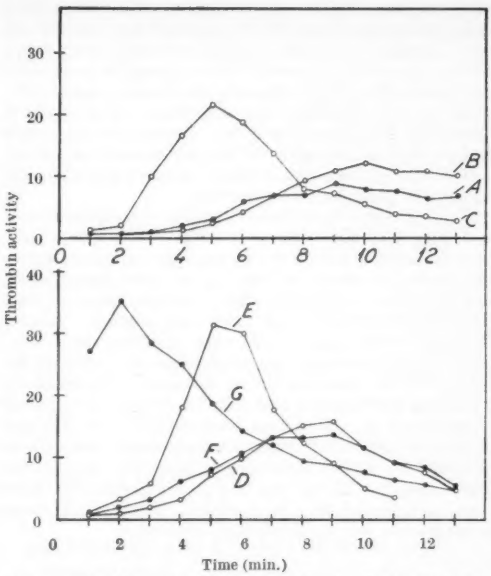


Fig. 1. Thrombin generation in horse plasma. *Abscissa*: reaction time in minutes; *ordinate*, reciprocal clotting time of fibrinogen solutions expressed as 600/*t* (*t* in sec.)

generation became normal (curve *E*), whereas the addition of plasma from a patient with Christmas disease and classical hæmophilia was without effect on the thrombin formation (curve *F*). Addition of a preparation of Christmas factor made according to Aggeler *et al.*[6] produced a very rapid generation and a high concentration of thrombin (curve *G*).

Apparently the defect in the thromboplastin system of horse plasma is caused by lack of Christmas factor.

This research was aided by grants from Kong Christian den Tiendes Fond and from the Josiah Macy Jr. Foundation, New York (to Dr. Tage Astrup).

Knud-Erik Sjølin

Biological Institute,
Carlsberg Foundation,
Copenhagen.
Feb. 22.

[1] Bell, W. N., Archer, R. K., and Tomlin, S. C., *Nature*, **175**, 596 (1955).
[2] Soulier, J. P., and Larrieu, M. J., *J. Lab. Clin. Med.*, **41**, 849 (1953).
[3] Macfarlane, R. G., and Biggs, R., *J. Clin. Path.*, **6**, 9 (1953).
[4] Pitney, W. R., and Dacie, J. V., *J. Clin. Path.*, **6**, 9 (1953).
[5] Sjolin, K.-E., *Scand. J. Lab. Clin. Invest.* (in the press).
[6] Aggeler, P. M., Spaet, T. H., and Byron, E. E., *Science*, **119**, 806 (1954).

A New Blood Parasite in British Pigs

Parasites of the genus *Eperythrozoon* do not appear to have been reported previously as occurring in the pig in Great Britain. In the United States Splitter[1] has recorded two species, *E. suis* and *E. parvum*; the former causes a disease known as ictero-anæmia in swine. We wish to report the occurrence of ring-like and coccoid structures, closely resembling those described by Splitter, in the blood of British pigs. The organisms are pleomorphic, rods, triangular and dumbbell forms occur; but ovoid rings or cocci are the most characteristic. The parasites are found in close association with the red

cells and may also be extra-cellular. They stain well with Giemsa and may also be detected when numerous with Leishman's stain. Other workers who have kindly examined infected blood smears concur with our opinion that the organisms are *Eperythrozoa*. (We wish to acknowledge the assistance of Dr. June Thurston, Molteno Institute, University of Cambridge, in this respect.) While we are as yet uncertain of the species concerned, it seems likely that the parasite is *Eperythrozoon parvum*.

The organisms have been found in seven splenectomized pigs less than three months old. They have been seen in the blood within nine days of splenectomy and have remained evident for at least seven days. Initially few in number, they increase until a peak infection is reached, then gradually regress. Recrudescences occur, and in one case this was associated with a mild anæmia (haemoglobin-level reduced by 3 gm./100 ml. and red blood cell counts reduced by 2 million per c.mm.) and a mild fever. A number of attempts at culture on bacteriological media and in developing chick embryos, together with transmission to small laboratory animals, have been unsuccessful. Three pig-to-pig transmissions have been accomplished. A detailed account of these experiments will be published elsewhere.

A. R. Jennings
John Seamer

Department of Animal Pathology,
School of Veterinary Medicine,
Madingley Road,
Cambridge.
March 7.

[1] Splitter, E. J., *Science*, **111**, 513 (1950).

Unexpected Anomalies in the Behaviour of Neutral Red and Related Dyes

The colour base of neutral red, 2-amino-8-N,N-dimethylamino-3-methylphenazine, together with 2-amino-8-N,N-dimethylaminophenazine (the colour base of 'neutral violet' in German usage), the amphoteric 8-amino-2-phenazinol, and 2-amino-7-N,N-dimethylaminophenazine have been made for the first time by unambiguous means: bomb-tube reactions of aqueous ammonia with the corresponding chloro- or bromo-N,N-dimethylaminophenazines, or with the halogenated 2-phenazinol[1]. The phenazines were made by ring closure through the nitro group of the corresponding 2-nitrodiphenylamines, according to the method of Waterman and Vivian[2].

None of the four compounds stained two species of *Amoeba* (*A. proteus* and *A. dubia*), or cells of sarcoma 37 ascites tumour when they were dissolved in dilute hydrochloric acid and the solutions brought to approximate neutrality. The staining power, on the other hand, was retained by the purified colour base of commercial neutral red (obtained by passing the crude dye twice through basic alumina), when this purified sample was likewise dissolved in dilute hydrochloric acid and the solution neutralized.

Analytical figures for carbon and hydrogen of this latter sample corresponded closely to the theoretical for aminodimethylaminomethylphenazine; the infra-red spectrum of the purified commercial base was ambiguous with regard to that of the synthetic 2-amino-8-N,N-dimethylamino-3-methylphenazine. This line of investigation is being continued. The melting points were different, however, for the base from the commercial dye melted with decomposition at 241–245°, while the synthetic base melted without decomposition at 166–167°. Also, the latter gave a brown colour with concentrated sulphuric acid, while the base from the commercial dye gave a green. In addition, the yellow solution of the synthetic base in ether showed a marked green fluorescence on exposure to ultra-violet light which was absent from the ether solution of the less-soluble purified commercial base.

Significantly, it was found possible to obtain forms of all three of the synthetic 2,8-substituted colour bases which gave vital stains when dissolved in dilute hydrochloric acid. These forms were made by dissolving the colour bases in concentrated sulphuric acid, diluting, and precipitating with ammonium hydroxide. The finely divided products were isolated by centrifuging. It is significant that the 2-amino-7-N,N-dimethylaminophenazine did not give a stain when subjected to this process.

The colour bases so obtained contained varying amounts of water, depending on the humidity of the atmosphere in which they were spontaneously dried; but in the instance of the colour base of neutral red, and presumably for the others, this water was not essential to the staining properties, which were retained undiminished when the compound was dried at 110°.

There apparently exists a third form, also, of the colour base of neutral red at least; for dissolving the synthetic compound in concentrated sulphuric acid and neutralizing directly by concentrated ammonium hydroxide, without prior dilution, produces a non-staining form which cannot be converted to the stain by subsequent treatment with sulphuric acid, dilution, and neutralization by ammonium hydroxide.

Both of the first two forms have been shown to be monomers in methanol solution by the Signer method[3].

Further investigation is being undertaken to determine the nature of the structural differences between the three forms.

We wish to acknowledge the technical assistance of Walter G. Hardy, and of Dr. W. C. Alford for molecular weight determinations.

Donald L. Vivian
Morris Belkin

Laboratory of Chemical Pharmacology,
National Cancer Institute,
National Institutes of Health,
Public Health Service,
U.S. Dept. of Health, Education and Welfare,
Bethesda 14, Maryland.
Feb. 9.

[1] Vivian, *J. Org. Chem.*, **21**, 565 (1956).
[2] Waterman and Vivian, *J. Org. Chem.*, **14**, 289 (1949).
[3] Clark, *Indust. Eng. Chem., Anal. Ed.*, **13**, 820 (1941).

Separation of Carbohydrates by Electrophoresis on Glass Filter Paper

In recent studies on the paper electrophoresis of carbohydrate compounds, we have found that replacing the cellulose filter paper by paper made from glass fibres[1] greatly facilitates the identification of sugars and their derivatives, especially those which are difficult or impossible to detect on cellulose paper.

Sugars, methylated sugars, sugar alcohols, lactones, sugar phosphates, neutral and acidic polysaccharides may be detected by spraying with a solution (0·5 per cent) of potassium permanganate in *N* sodium hydroxide. The more stable methylated methyl

glycosides, methylated polysaccharides and acetal derivatives of sugars are readily detected by spraying with a solution (5 per cent) of 1-naphthol in 10 *N* sulphuric acid.

The paper electrophoresis experiments were carried out in a 'sandwich' type of apparatus[2,3]. The glass paper (made with 3 A. fibre and no organic binder)[1], held between two thin insulating sheets of polythene, is placed on a sheet of foam rubber (0·5 in. thick) and clamped between two sheets of plate glass (0·25 in. thick) by means of two simple wooden clamps[2]. The foam rubber enables an even pressure to be applied to the paper[3]. Since evaporation is prevented, cooling need not be applied except when dealing with proteins, in which case the upper glass plate is replaced by one to which has been cemented a 'Pyrex' dish and through which cold water can be circulated[2].

For electrophoretic analysis of carbohydrates, 0·1 *M* sodium tetraborate was used as the buffer, a voltage of 600 was applied and separations were carried out for 0·5–3 hr., depending on the nature of the substances being examined. Ethylene glycol, D-glucose, tetra-O-methyl D-glucose or its methyl glycoside were used as reference compounds. After the separation, the paper, still containing borate buffer, was placed on a glass plate and dried in the oven at 100° and, while still hot, the reagent was applied as a spray in the usual way. With the 1-naphthol reagent mono-, oligosaccharides, methyl sugars, glycosides, sugar acetals, polysaccharides and methyl polysaccharides were located by the appearance of dark blue spots on a white background, while with alkaline permanganate all oxidizable compounds were detected by the appearance of well-defined white or pale yellowish brown spots on a pink or greenish-pink background. The same glass fibre paper chromatogram may be subjected to the alkaline permanganate treatment (this detects all the oxidizable components), and then with the acidified 1-naphthol reagent (this detects sugar derivatives that escape permanganate oxidation).

Many other substances, including the amino-acids, proteins, sterol glycosides, organic acids and phenols, can be separated in the same manner and readily identified by taking advantage of the fact that a wide variety of reagents and conditions may be used for locating the substances on the glass papers.

Using glass instead of cellulose paper, the possibility of combination between polyhydroxy compounds and the paper through a common borate ion is impossible, whereas this is not necessarily the case when cellulose paper is employed. Hence, structural deductions from borate complex formation, as revealed by electrophoresis, are likely to be more reliable when glass paper is used instead of cellulose paper. The method has proved useful in the separation and comparison of *cis* and *trans* C_5, C_6, and C_7 saturated cyclic diols and other cyclic and straight-chain polyols. The steric effect of neighbouring groups and of the nature and size of rings on vicinal hydroxyl groups has also been investigated.

It will be apparent that this method will also simplify certain quantitative determinations which, hitherto, have had to take into consideration material extracted from the cellulose filter papers, and it is also likely that electrophoresis on thick sheets of glass paper will prove to be useful for preparative work.

The glass filter paper can be re-used after a suitable washing treatment, and a further saving can be effected by using glass paper only for the central portion of the chromatogram, with overlapping extensions of cellulose filter paper to make contact with the buffer solution.

Further details of this work will appear elsewhere.

We wish to thank the National Bureau of Standards, Washington 25, D.C., through the courtesy of Dr. R. B. Hobbs and Dr. M. J. O'Leary, for the glass fibre papers.

D. R. Briggs
E. F. Garner
F. Smith

Institute of Agriculture,
University of Minnesota,
St. Paul 1,
Minnesota.
March 21.

[1] O'Leary, M. J., Hobbs, R. B., Missimer, J. K., and Erving, J. J., *Tappi*, **37**, 446 (1954).
[2] Briggs, D. R., Garner, E. F., Montgomery, R., and Smith, F., *Anal. Chem.* (in the press).
[3] Cf. Kunkel, H. G., "Methods of Biochemical Analysis", Ed. D. Glick, p. 141, Interscience, New York (1954); Lederer, M., "Introduction to Paper Electrophoresis and Related Methods", Elsevier Publishing Co., New York (1955).

Spectrum of the Cyclopentadienyl Radical

The great stability of benzene has aroused much interest in the properties of other planar symmetrical cyclic species of formula $(CH)_n$. For even values of n, only cyclo-octatetraene is stable, and is of limited interest owing to puckering of the ring[1]. The odd series can exist only as radicals or ions and, while several calculations have been made of their resonance energies[2–4], only $C_7H_7^+$ has been observed spectroscopically[5], although the acidity of cyclopentadiene[6] provides evidence for the stability of the ion $C_5H_5^-$. Like benzene, both these species have six π-electrons and are expected to have higher resonance energies than the 38 k.cal. predicted for the cyclopentadienyl radical (C_5H_5)[3,4].

Experiments have been carried out on the flash photolysis of both cyclopentadiene and 'ferrocene' (biscyclopentadienyl iron) in the gas phase using the apparatus previously described[7]. Pressures of 1–10 mm. of cyclopentadiene or 1 mm. of ferrocene diluted with 250–750 mm. of inert gas (nitrogen or carbon dioxide) to limit the rise in temperature were used. In all these mixtures, the spectrum shown in Fig. 1 was observed during the photolysis but disappeared rapidly, its half-life being less than 10^{-4} sec. This spectrum consists of two heads at 29,581 and 29,911 cm.$^{-1}$, which are relatively sharp, having widths of about 10 cm.$^{-1}$; this spectrum must presumably be due to the C_5H_5 radical, since it is difficult to visualize any other transient species except atoms which would be formed directly in the photolysis of both these compounds. Furthermore, recent calculations by McEwen and Longuet-Higgins[8] using a semi-empirical molecular orbital treatment predict an E_1'' ground-state for this radical, with an A_2'' first excited state to which a transition would be allowed (transition moment symmetry—E_1'). Neglecting second-order interactions, they find an excitation energy of 4·02 eV. for this state, which is in strikingly good agreement with the observed values of 3·67 and 3·70 eV. Also, they predict that there will be no other states lying below 6 eV., which is in accordance with the absence of further absorption bands above the limit of observation at 2400 A.

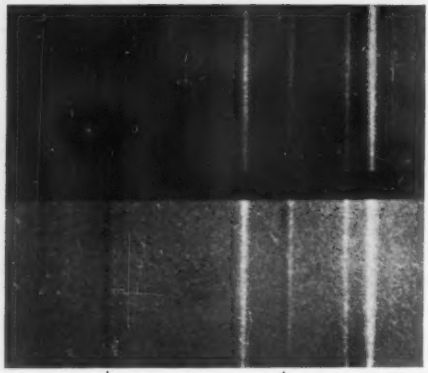


Fig. 1. Absorption spectrum attributed to the cyclopentadienyl radical

The decay of the C_5H_5 radical is accompanied by the appearance of featureless continuous absorption below 3500 A., due to a stable product which has not yet been investigated. In the absence of an inert gas, the rise in temperature due to the light energy absorbed by either cyclopentadiene or ferrocene is insufficient to produce appreciable thermal decomposition; under these conditions, the continuous absorption by the products appears without the intensity of the C_5H_5 spectrum reaching the limit of detection. This increase in the rate of the reactions removing the radical indicates that they have an appreciable activation energy, which is not surprising in view of the high resonance energy expected for C_5H_5. During this photolysis in the absence of inert gas, ferrocene shows strong absorption from iron atoms in the sub-levels of the (x^5D) and (a^5F) states, the latter being intense enough to suggest that the iron atoms might be liberated in this state.

I wish to express my gratitude to Miss K. L. McEwen and Prof. H. C. Longuet-Higgins for permission to quote results from an unpublished paper.

B. A. Thrush

Department of Physical Chemistry,
University of Cambridge. March 21.

[1] Karle, I. L., *J. Chem. Phys.*, **20**, 65 (1952).
[2] Hückel, E., *Z. Physik*, **70**, 204 (1931).
[3] Roberts, J. S., and Skinner, H. A., *Trans. Farad. Soc.*, **45**, 339 (1949).
[4] Franklin, J. L., and Field, F. H., *J. Amer. Chem. Soc.*, **75**, 2819 (1953).
[5] Doering, W. von E., and Knox, L. H., *J. Amer. Chem. Soc.*, **76**, 3203 (1954).
[6] Thiele, J., *Ber.*, **33**, 666 (1900).
[7] Norrish, R. G. W., Porter, G., and Thrush, B. A., *Proc. Roy. Soc.*, A, **216**, 165 (1953).
[8] McEwen, K. L., and Longuet-Higgins, H. C. (to be published).

A Test of the 'Redox' Hypothesis of Active Ion Transport

The concept that the electron transfer in the oxidation–reduction reactions of respiration constitutes the driving force for active ion transport has provided the basis for several hypotheses of ion transport[1–7]. All these have in common the quantitative limitation that no more than four univalent ions can be actively transported per molecule of oxygen consumed, because oxygen can accept just four electrons per molecule in its complete reduction.

To test this 'redox' hypothesis of ion transport, simultaneous measurements were made of active ion transport and oxygen consumption by isolated frog skin. Ussing and Zerahn[8] have shown that, with the same solution bathing both sides of an isolated frog skin, the short-circuit current measured, when a counter potential is applied across the skin so as to reduce the spontaneous membrane potential to zero, is equal to the net sodium transport through the skin. Hence the short-circuit current was taken as the measure of active sodium transport. Oxygen consumption was measured polarographically with a vibrating platinum micro-electrode[9].

A total of eighty-seven individual, simultaneous measurements of oxygen consumption and active ion transport was made on the ventral skins of nineteen frogs (*Rana temporaria*). The ratio of ions transported to molecules of oxygen consumed was found to range from 2 to 13 with a mean of 6·93 and standard error of the mean of $\pm$ 0·21. In all but five periods this ratio was above 4·0. The experimental error propagated into the determination of a single value of this ratio is estimated to be $\pm$ 9 per cent.

These results are incompatible with the 'redox' hypothesis of ion transport in which molecular oxygen is the electron acceptor. Similar results in this same tissue have recently been obtained by Zerahn[10].

Active sodium transport through the frog skin is augmented by neurohypophyseal preparations of mammalian origin[8]. We find in all but one of sixteen experiments that this effect is associated with a simultaneous increase of oxygen consumption by the stimulated membrane. Thus the mean rates of sodium transport for the sixteen periods just before and the sixteen periods just after addition of neurohypophyseal preparations were 1·69 and 2·76 μequiv./cm.^{2}/hr. respectively, the mean difference was 1·07 and its *S.E.* $\pm$ 0·089 and $P < 0{\cdot}001$. The mean figures for oxygen consumption for the same periods were 0·278 and 0·341 μmole/cm.^{2}/hr., the mean difference was 0·063 and its *S.E.* $\pm$ 0·0129 and $P < 0{\cdot}001$. If the one experiment in which no stimulation of oxygen consumption was observed is excluded, the mean ratio of increment of sodium transport to increase in oxygen consumption following stimulation of the skin with neurohypophyseal preparations was 21·1 $\pm$ 3·0 sodium ions transported per molecule of the increment of oxygen consumed. Though such a calculation is open to some criticism[11], this mean figure of the ratio of increase in sodium transport to increase in oxygen consumption represents the best estimate possible at present of the actual stoichiometric relationship of ion transport to oxygen consumption by the fraction of cells in this tissue engaged in the ion transport process.

The minimum energy required for the active ion transport process constitutes 8 and 10 per cent of the total energy available to the tissue from aerobic metabolism before and after stimulation with neurohypophyseal preparations, respectively, and 22 per cent for the increment of ion transport and oxygen consumption following hormonal stimulation. Thus no inconsistency is encountered when the energetics of the observed rates of ion transport are considered.

Previous attempts to evaluate the relationship of ion transport to oxygen consumption in this tissue have been made. Stapp and Lund[12] obtained values close to 4 but realized that, as they were not using a totally short-circuited skin preparation, their results gave only a minimal value. Linderholm[13] has estimated this relationship and his results give a value of 3·28. However, his oxygen and ion transport measure-

ments were not made simultaneously on the same skin but were mean figures. More important, the skins used in his study gave very low rates of ion transport averaging 0·7 μequiv./cm.²/hr. as compared with our higher values recorded above. Thus, even though our values for oxygen consumption are higher than his, the ion transport rates were sufficient to give the higher ratios produced here.

The results indicate that the 'redox' hypothesis of ion transport in which oxygen is the final electron acceptor is quantitatively insufficient to account for observed rates of ion transport and oxygen consumption by the isolated, short-circuited frog skin.

The full paper will be published in due course.

ALEXANDER LEAF
ALAN RENSHAW

Medical Research Council
Unit for Research in Cell Metabolism,
Department of Biochemistry,
University of Oxford,
and the Howard Hughes Medical Institute.

[1] Friedenwold, J. S., and Stiehler, R. D., *Arch. Ophth.*, **20**, 761 (1938).
[2] Stiehler, R. D., and Flexner, L. B., *J. Biol. Chem.*, **126**, 603 (1938).
[3] Lundegårdh, H., *Ann. Agric. Coll.*, Sweden, **8**, 233 (1940).
[4] Conway, E. J., and Brady, T. G., *Nature*, **162**, 457 (1948); *Science*, **113**, 270 (1951); *Int. Rev. Cytol.*, **2**, 419 (1953); **4**, 377 (1955).
[5] Crane, E. E., and Davies, R. E., *Biochem. J.*, **43**, xlii (1948); **46**, 324 (1950).
[6] Patterson, W. B., and Stetten, jun., D., *Science*, **109**, 256 (1949).
[7] Rehm, W. S., *Gastroent.*, **14**, 401 (1950).
[8] Ussing, H. H., and Zerahn, K., *Acta Phys. Scand.*, **23**, 110 (1951).
[9] Chance, B., and Williams, G. R., *Nature*, **175**, 1120 (1955).
[10] Zerahn, K., *Acta Phys. Scand.*, **36**, 300 (1956).
[11] Davenport, H. W., *Fed. Proc.*, **11**, 715 (1952).
[12] Lund, E. J., and Stapp, P., in "Bioelectric Fields and Growth", 235 (edit. by Lund, E. J., University of Texas Press, Austin).
[13] Linderholm, H., *Acta Phys. Scand.*, **27**, 97 (1952).

Formation of Hydroperoxides from Nucleic Acids by Irradiation with X-Rays in Aqueous Systems

IN the course of our studies of the chemical effects of X-rays on nucleic acids in aqueous solutions[1], we have had occasion to measure the amounts of peroxide produced. Two methods were employed: (*a*) the reaction with titanium sulphate reagent[2] and spectrophotometric measurement of the resulting complex at 405 mμ; (*b*) the oxidation of potassium iodide[3] and determination of the liberated iodine (I_3^-) by the absorption at 353 mμ. It was found that, in solutions of thymus deoxyribonucleic acid and also of yeast ribonucleic acid irradiated in the presence of oxygen, the yields of total peroxide, as determined by the iodide method, were always greater than those of hydrogen peroxide, estimated by titanium sulphate. This observation can be explained by the presence of organic hydroperoxides in the irradiated nucleate solutions, since it is known that hydroperoxides will oxidize iodide ions, but do not give, in general, the coloured complex with the titanium sulphate reagent.

For example, in the irradiation of deoxyribonucleic acid solutions (0·1 per cent w/v, Signer acid, *p*H ~7) with X-rays (200 kV.), in the presence of oxygen (1 atm.), with a total dose of $\simeq 3 \times 10^4$ rep, the yield of total hydroperoxides was $G = 2{\cdot}5$ (molecules/100 eV.), whereas for hydrogen peroxide $G = 1{\cdot}5$; this gives a difference of $G = 1{\cdot}0$ to be accounted for by organic hydroperoxides.

These hydroperoxides showed a marked post-irradiation decay. In the case of the above-mentioned deoxyribonucleic acid solutions, the disappearance of the organic hydroperoxides could be accounted for on the basis of the occurrence of two simultaneous first-order processes, with half-lives of about 1 hr. and 30 hr. respectively (at 25° C.).

In order to throw some light on the nature of the hydroperoxides in irradiated nucleate solutions, experiments have been carried out with several ribonucleotides and ribonucleosides and also with the corresponding purine and pyrimidine bases. Evidence for the presence of hydroperoxides was obtained in irradiated solutions of uridine-3′-phosphate, uridine, cytidine-3′-phosphate, cytidine and with uracil and thymine; but negative results were found with guanosine-3′-phosphate, the adenosine-3′- and 5′-phosphates, as well as with adenosine and with adenine. Hence, we may conclude that these hydroperoxides are associated with the pyrimidine bases. These experiments suggest that the two different hydroperoxides which are found in the irradiated deoxyribonucleic acid solutions are derived from the two pyrimidine components.

The presence of molecular oxygen during irradiation is essential for the production of hydroperoxides from these compounds. This is in agreement with the general idea that the formation of organic hydroperoxides proceeds through the addition of molecular oxygen to the free radical, $R\cdot$ (formed by the action of a radiation-produced OH radical on the solute, *R*H), leading to the formation of an organic peroxy-radical $RO_2\cdot$, which, on reduction, can form a more or less stable organic hydroperoxide (RO_2H) [4].

The production of such hydroperoxides from deoxyribonucleic acid and ribonucleic acid may be of considerable importance from a radiobiological point of view; in particular, this may have a bearing on some delayed effects of ionizing radiations *in vivo*.

Work on related and various other compounds of biological importance is in progress.

Full details will be published elsewhere.

Note added in proof. It has now been found that the formation of hydroperoxides from these compounds can also be induced by irradiation of their aqueous solutions with ultra-violet light in the presence of oxygen.

We wish to thank the North of England Council of the British Empire Cancer Campaign and the Rockefeller Foundation for financial support.

G. SCHOLES
J. WEISS
C. M. WHEELER

University of Durham, King's College,
Newcastle upon Tyne 1. May 29.

[1] cf. Scholes, G., and Weiss, J., *Biochem. J.*, **56**, 65 (1954).
[2] cf. Eisenberg, G. M., *Indust. Eng. Chem., Anal. Ed.*, **15**, 327 (1943).
[3] cf. Hochenadel, C. J., *J. Phys. Chem.*, **56**, 587 (1952).
[4] Johnson, G. R. A., and Weiss, J., *Chem. and Indust.*, 358 (1955); Report A.E.R.E., Harwell, October 1954.

Influence of Surface Oxygen in the Activation of Carbonized Coals by Partial Combustion

IT has long been appreciated that surface compounds as well as gaseous oxides are formed when carbons and oxygen interact. Rhead and Wheeler's original suggestion[1] that the so-called surface oxides are intermediates in the overall reaction mechanism is not borne out by more recent work[2,3], which shows that at least a proportion of the oxides should be regarded as by-products of the main reaction.

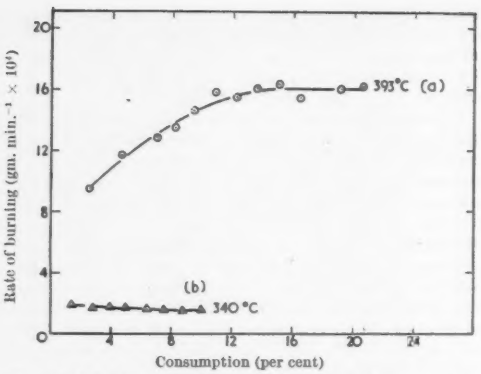


Fig. 1. Relation between rate of burning and per cent consumption for 812° C. char burned at two temperatures at an oxygen partial pressure of 20 per cent of 1 atmosphere: *a*, 393° C.; *b*, 340° C.

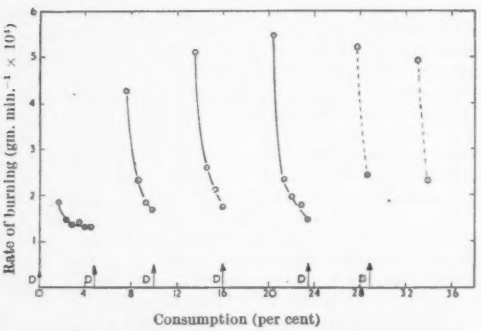


Fig. 2. Relation between rate of burning and per cent consumption for 812° C. char burned at 340° and 7·7 per cent oxygen partial pressure with periodic degassing (*D*) of the fuel in nitrogen at 750° C. Initial charge 3·1 gm. Size-range 7–10 B.S.S.

A study of the slow reaction in oxygen of several carbons covering a wide range of reactivity has shown clearly that surface oxygen can retard the normal development of reactivity of porous carbons accompanying their partial consumption. The reaction was followed by gravimetric estimation of the oxides of carbon in the outflow gases, in which large quantities of oxygen were still present. Under suitable conditions (reactive fuel and low reaction temperature), consumption of the fuel did not lead to the increase in reaction-rate that would be expected as a result of marked activation. For example, the curves in Fig. 1 show the variation in rate of gasification with extent of consumption for one fuel at two working temperatures, namely, 340° and 393° C. In the latter case (curve *a*) the increase in rate with consumption indicates marked activation, whereas in the former (curve *b*) the rate shows little change. The influence of surface oxygen in determining the form of curve *b* was demonstrated by interrupting a run and heating the carbon, in an atmosphere of nitrogen, to a temperature slightly below that of its preparation. This process led to the release of oxides of carbon from the sample. On cooling to reaction temperature and re-admitting oxygen a very high initial reaction-rate was observed which decayed rapidly towards its previous low value. This cycle may be repeated (Fig. 2). With more reactive fuels, exposure to oxygen after degasification often led to uncontrollable temperatures.

The precise mechanism of retardation by surface oxygen is unknown; activation of porous fuels is thought to proceed mainly by an 'opening up' of the internal structure. This presumably goes on while the surface oxides are present on the fuel; but the new surface is not available for rapid combustion until the oxides are removed. This effect would provide a reason, apart from temperature control, for preferring to activate fuels in steam rather than in air or oxygen; for, so far as we are aware, no oxide by-products from the steam/carbon reaction have been reported.

This role of surface oxygen in the practical ignition of a fuel on a grate is probably small if auxiliary sources of ignition are used, since the temperature-range in which the surface oxides would be most influential is rapidly traversed.

J. R. Arthur
E. J. Newitt
M. M. Raftery
British Coal Utilisation Research Association,
Randalls Road, Leatherhead. March 13.

[1] Rhead, T. F. E., and Wheeler, R. V., *J. Chem. Soc.*, **101**, 846 (1912).
[2] Barrer, R. M., *J. Chem. Soc.*, 1260 (1936).
[3] Strickland-Constable, R. F., *Chem. and Indust.*, 771 (1948).

Solid-State Reaction in the System ZrO_2—Al_2O_3—SiO_2

A number of compositions at 10 per cent intervals along three possible compatibility joins within the system have been heated at 1,650° C. All were formulated from mixtures of the pure oxides and, where applicable, a high-grade natural zircon.

X-ray analysis of calcined specimens of the series of simple oxide mixtures equivalent to compositions along the possible compatibility join ZrO_2—$3Al_2O_3.2SiO_2$ showed each to consist of a binary mixture of zirconia and mullite. The exclusive presence of these two solid phases suggested the validity of the join. Confirmation of the non-existence of the intersecting join Al_2O_3—$ZrO_2.SiO_2$ was provided by the fired nature of the series of compositions along it. The first five members (90–50 per cent Al_2O_3) of the series were found after calcination to comprise ternary mixtures of zirconia, mullite and alumina, while the last four (40–10 per cent Al_2O_3) consisted of ternary mixtures of zirconia, zircon and mullite. If the join were valid, solid-state reaction would have resulted in the production of binary mixtures of alumina and zircon in all cases. The X-ray diffraction charts of compositions made up with natural zircon clearly indicated the disappearance of this phase immediately the valid join ZrO_2—$3Al_2O_3.2SiO_2$ was crossed from the side of zircon to the side of alumina. The absence of zircon in fired specimens of a control composition equivalent to the mixture 60 per cent Al_2O_3, 40 per cent $ZrO_2.SiO_2$, which had been prepared from the simple oxides, and its successful synthesis in similar specimens corresponding to the mixture 30 per cent Al_2O_3, 70 per cent $ZrO_2.SiO_2$, was considered strongly to confirm the indicated location of these compositions within dissimilar compatibility triangles.

A series of mixtures of zircon, alumina and silica corresponding to points along the possible compatibility join $ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$ were found after calcination to be predominantly binary mixtures of zircon and mullite. Further confirmation of the validity of the join was provided by fired specimens of a composition equivalent to the mixture 40 per

cent $ZrO_2.SiO_2$, 60 per cent $3Al_2O_3.2SiO_2$, which was made up from the simple oxides. The X-ray diffraction chart of these specimens showed them to be essentially a mixture of zircon and mullite, an indication that the simultaneous synthesis of the two end members had occurred.

Experimental evidence of the validity of the compatibility joins ZrO_2—$3Al_2O_3.2SiO_2$ and $ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$ points to the existence of the three compatibility triangles or sub-systems ZrO_2—$3Al_2O_3.2SiO_2$—Al_2O_3, ZrO_2—$ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$ and $ZrO_2.SiO_2$—SiO_2—$3Al_2O_3.2SiO_2$ within the ternary system ZrO_2—Al_2O_3—SiO_2. The fired nature of the specimens of the three series studied gave no indication of ternary compound formation on either of the two valid joins or within the compatibility triangles ZrO_2—$3Al_2O_3.2SiO_2$—Al_2O_3 and ZrO_2—$ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$. A final composition within the compatibility triangle $ZrO_2.SiO_2$—SiO_2—$3Al_2O_3.2SiO_2$ indicated that it also was free from additional compound formation. Evidence of partial fusion was apparent in compositions at the high —$ZrO_2.SiO_2$ end of the series Al_2O_3—$ZrO_2.SiO_2$ and $ZrO_2.SiO_2$—$3Al_2O_3.2SiO_2$. These compositions are in the vicinity of the binary eutectic between alumina and zircon at about 20 per cent Al_2O_3 and 1,680° C., previously reported by Rea[1]. Glass formation was associated with considerable decomposition of the zircon present. The results obtained are only partially in agreement with those of a recently published investigation of solid-state reaction in the quaternary system MgO—Al_2O_3—SiO_2—ZrO_2 [2]. The earlier investigation was carried out at considerably lower temperatures.

A more detailed account of this work will be published elsewhere.

H. Fowler

School of Chemical Engineering,
New South Wales University of Technology.
March 12.

[1] Rea, R. F., *J. Amer. Ceram. Soc.*, **22**, 95 (1939).
[2] Herold, P. G., and Smothers, W. J., *J. Amer. Ceram. Soc.*, **37**, 351 (1954).

Class II Radio Signals from Venus at a Wave-length of 11 Metres

In two earlier communications[1], the reception of impulsive radio signals from the planet Venus at a wave-length of 11 metres was reported. These signals have burst-like characteristics somewhat resembling atmospherics from terrestrial thunderstorms and may presumably originate in similar storms on Venus. The bursts are of very short duration, being a small fraction of a second.

The purpose of this third communication is to report the reception at the Ohio State University of radio signals of a distinctly different kind which also appear to come from Venus. For convenience, these signals will be referred to as Class II signals, while the previously reported atmospherics-like signals will be designated Class I signals. The same equipment as described earlier has been used for receiving both types of signals.

The Class II signals are usually of a more sustained type, lasting about 1 sec. or considerably more, and appear to be modulated at an audiofrequency-rate. Modulation frequencies in the neighbourhood of 15, 60, 125 and 150 c./s. have been noted. The emissions are slightly reminiscent of signals from a terrestrial radio telegraph station, and they were at first presumed to be interference from this type of station. However, over many weeks they were observed to appear only when Venus was in the antenna beam of the radio telescope and usually seemed to be strongest when Class I signals were also being received with greatest strength. Sustained signals of several seconds duration have also been observed from Jupiter[2]. These have a very low-frequency modulation of 30 c./s. or lower.

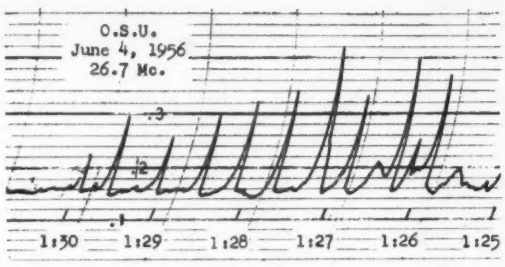


Fig. 1. A series of Class II pulses received on June 4, 1956, at 11 m. wave-length

One of the most prominent Class II signals has a modulation of approximately 125 c./s. and occurs in pulses of about 1 sec. duration. Fig. 1 shows recorder indications of a series of such pulses received on June 4, 1956. The pulses may occur at intervals of a few seconds to a minute or more. In the group shown in Fig. 1 the intervals are mostly between 20 and 30 sec. On some occasions when pulses were being detected, it was observed, by tuning the receiver, that they could be received over a frequency-range of at least 2 Mc./s. Since each pulse has a sloping front and an abrupt termination, the detection over a 2 Mc./s. frequency-range cannot be due to a narrow band pulse swept rapidly in frequency since this would produce a symmetrical pulse having the same shape as the receiver band-pass characteristic. Hence, it appears that the pulses possess a band-width of at least 2 Mc./s.

The pulses are not usually observed for a long enough period of time (rarely more than 5 or 10 min.) to obtain a conclusive interferometer lobe pattern, and although it appeared likely that these signals might be of Venusian origin some independent type of observation was needed to make the identification more definite. This came about from a study of the magnetic sound tapes, on which the audio output of the receiver had been recorded; when it was noted

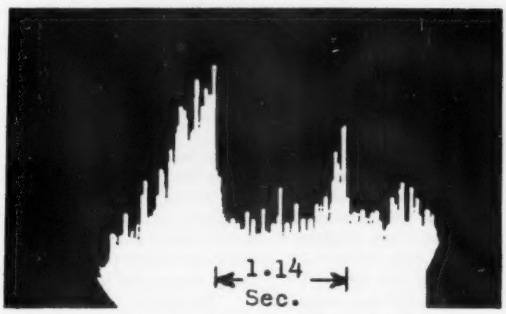


Fig. 2. Class II pulse with echo observed about 1.15 p.m. E.S.T. on June 4, 1956. Time increases to the right, the echo being the smaller peak to the right of the main one

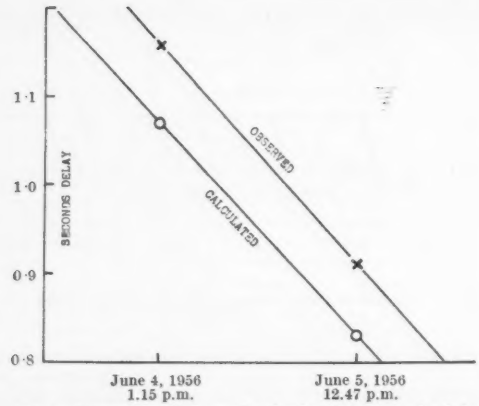


Fig. 3. Comparison of observed and calculated moon echo delay times

that on rare occasions a pulse was followed by a weaker one which sounded like an echo. Two such pulses with echoes were noted on the sound tape for June 4, 1956, occurring within a few minutes of each other about 1.15 p.m. E.S.T. One of the pulses with echo is shown in Fig. 2 as photographed on a cathode-ray oscillograph. This pulse echo has a measured delay time of 1·14 sec. The other pulse echo delay was 1·18 sec., giving an average of 1·16 sec. The Moon was above the horizon at the time and the calculated delay time for a signal reaching the Earth from Venus through a Moon reflexion with respect to a signal reaching the Earth directly from Venus was about 8 per cent less. A search for more pulses with echoes revealed a single one on the sound tape of June 5, 1956, at 12.47 p.m. E.S.T. This one had a measured delay of 0·91 sec. The calculated delay was 0·83 sec., the movement of the Moon causing a reduction in the echo delay time of 0·24 sec. (1·07–0·83) between the times of observation on June 4 and 5. It is highly significant that the observed delay time changed by 0·25 sec. (1·16–0·91) or by nearly the same amount. The results are compared in Fig. 3.

There appears to be a consistent difference between the observed and calculated delay times on the two days due to a relatively constant experimental effect, but the change in both observed and calculated times is very nearly equal. The probability of this being a coincidence or due to some other cause is very small, so that it appears that the pulses are of Venusian origin. A lower signal velocity than for waves in empty space could account for the difference between the observed and calculated values, but any such reduction in velocity would probably be sufficiently small to account for only a portion of the difference.

To receive a Moon echo of the strength observed requires about fifty decibels more echo-power than the Moon would provide as a uniform spherical scatterer of radio waves. Nevertheless, such enhancement could occur if a relatively large flat area of the Moon were properly oriented so as to give a direct reflexion to the Earth. In fact, if the surface in question were slightly concave (as a shallow valley) and of approximately parabolic contour, with the Earth at the focus, very large increases in power of echo could be expected. However, the proper orientation of the Moon to obtain such a reflexion would be a rather rare occurrence, which would account for the fact that echoes are seldom observed.

I am indebted to Dr. H. C. Ko for making independent calculations of the echo delay times.

John D. Kraus

Radio Observatory,
Department of Electrical Engineering,
Ohio State University,
Columbus 10, Ohio.
June 25.

[1] Kraus, J. D., *Nature*, [178, 33 and 103 (1956)].
[2] Kraus, J. D., *Sky and Telescope*, **15**, 358 (1956); *Astron. J.*, **61**, 182 (1956).

Diffraction of Light by Ultrasonic Waves at 300 Mc./s.

The highest frequency so far adopted for the study of diffraction of light by ultrasonic waves is 180 Mc./s. reported by Bhagavantam and Rao[1]. Diffraction patterns at these frequencies were found to show some unusual and interesting features which were studied in detail by these authors.

Using an *RCA* 826 valve in a parallel line oscillator circuit and a *z*-cut precious red tourmaline crystal 0·6 mm. thick, we have recently been able to push up this frequency to nearly 300 Mc./s. and study the diffraction effects due to progressive waves set up in water. Diffraction patterns could be observed at all frequencies up to 300 Mc./s. by exciting the crystal at one of its odd harmonics. In order to measure dispersion, if any, of ultrasonic velocity in water, the crystal has been excited at the highest frequency and another lower frequency and the diffraction patterns photographed on the same plate at about the same time using a camera of 21-cm. focal-length. Fig. 1 shows the patterns at the two frequencies of 50·34 and 297·03 Mc./s. photographed at the Bragg angle of incidence for the higher frequency, using the mercury green line as the source of light.

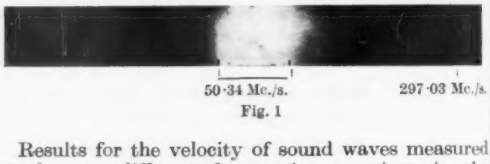


Fig. 1

Results for the velocity of sound waves measured at the two different frequencies are given in the accompanying table along with the fringe-width and the order of the harmonic of the crystal which was excited. The lower frequency was measured accurately by a Marconi precision heterodyne wave-meter while the highest frequency was measured by using a Lecher-wire set up.

In view of the appreciable angle of diffraction (6° 10′) at the higher frequency, it is not possible to approximate sin θ to tan θ and take the fringe-width as proportional to the frequency as is usually done in the lower frequency-range. The velocity at 300 Mc./s. is calculated by evaluating sin θ from the value of d/D. The sound beam at 300 Mc./s. is confined close to the surface of the crystal due to heavy absorption, and as the liquid in contact with the crystal is sub-

Table 1. Focal Length of the Camera D = 21 cm.

Order of harmonic	Frequency ν (megacycles per sec.)	Fringe-width d (cm.)	$\frac{\nu}{d}$	Velocity (m. per sec.)	Temp. (° C.)
9	50·34	0·3844	130·6	1,502	24·8
53	297·03	2·2744	130·9	1,508	27·0

ject to heavy radio-frequency heating the average temperature of the liquid could not be determined quite accurately. Considering the uncertainty in the measurement of this temperature, the results may be taken to indicate that there is no dispersion of ultrasonic velocity in water up to 300 Mc./s. The values for the velocity are in fairly good agreement with those reported by other investigators. The wave-length of sound in water corresponding to 297·03 Mc./s. employed in this investigation is 0·000503 cm., which is only about twelve times the wave-length of mercury green light in water.

The general features of the diffraction pattern at 300 Mc./s. are similar to those at 180 Mc./s. reported earlier. The sharpness of the appearance of the diffraction line around the Bragg angle of incidence is, however, more prominent at the higher frequency. Quantitative study of the variation of intensity of the diffraction pattern with angle of incidence and width of the sound field is in progress and the results will be reported in due course.

B. Ramachandra Rao
J. Satyanarayana Murty
Physics Department,
Andhra University,
Waltair.
Feb. 24.

[1] *Nature*, **161**, 927 (1948); *Proc. Ind. Acad. Sci.*, **28**, 54 (1948).

Calibration of Vibration Pick-ups at High Frequencies using a Michelson Interferometer

Most existing methods of calibrating vibration pick-ups employ some form of extrapolation, that is, the pick-up is calibrated at low frequencies, where the amplitude can be made large, and the result is then extended to higher frequencies. Since it is considered that this method is unsatisfactory, a Michelson interferometer capable of measuring vibratory amplitudes down to 4×10^{-6} in. has been constructed. The upper limit of the calibration frequency is largely determined by the type of vibration pick-up and by the driving vibrator, but the present arrangement can be used up to 10 kc./s.

The Michelson interferometer takes its usual form except that it is mounted in a vertical plane for convenience. One of the two mutually perpendicular mirrors is attached to a block on the vibrator armature and the vibration pick-up is fixed to the same block. Using monochromatic light (in this case the green line of mercury at 5461 A.), circular fringes are set up in the usual manner. As the vibration amplitude is slowly increased, the fringes alternately disappear and reappear. The disappearance, that is, when the field of view is apparently uniformly illuminated, is quite sharp and each disappearance corresponds to a definite amplitude of vibration of the moving mirror, and Ostberg (1932) has calculated these amplitudes. Provided the vibration wave-form is a pure sinusoid, these amplitudes are determined by a Bessel function of order zero and the first three values are approximately 4·1, 9·4 and 14·8 millionths of an inch for a light wave-length of 5461 A.

Preliminary experiments have shown that this apparatus can be used for calibrating a barium titanate accelerometer over a frequency-range of 500 c./s. to 10 kc./s. It can also be used for proving that the output of the accelerometer at a given frequency is proportional to the amplitude of vibration, that is, to the acceleration.

S. M. Davies
E.M.I. Engineering Development, Ltd.,
Victoria Road,
Feltham,
Middlesex.
March 29.

Inadequacy of Recombination as the Source of Light from Enduring Meteor Trains

It has been suggested[1,2] that the enduring column of light left by a meteor in its passage across the sky is produced by radiative recombination of the meteoric ions and free electrons. We wish to criticize this hypothesis on a quantitative basis.

Consider a line of q ion pairs per cm. which diffuse with an ambipolar diffusion coefficient D cm.²/sec. to form a column with a Gaussian cross-section.

Let α_e be the recombination coefficient of the ions and electrons and p be the luminous energy emitted per recombination event between wave-lengths 4680 A. and 5560 A. The luminous energy, I, emitted per cm. of train per second is then given by the equation

$$I = \frac{p\,\alpha_e\,q^2}{8\pi D t} \qquad (1)$$

where t is the time that has elapsed since the passage of the meteor.

Let us consider a Perseid and a Geminid meteor with absolute visual magnitudes $-2{\cdot}0$ and $-3{\cdot}0$ respectively. The work of various authors enables us to compute the brightness of the train from equation (1).

(i) Öpik[2] has computed the visual intensities from the cascade spectra for recombination of the ions that are to be expected in meteor columns; he finds that the most efficient reaction is Fe II $(a^4p) + e \rightarrow$ Fe I, where $p = 1{\cdot}51 \times 10^{-12}$ ergs. Öpik computed the recombination coefficient for this reaction and for recombination events involving other atoms. After correction to a temperature of 212° K., we may adopt $\alpha_e = 2{\cdot}6 \times 10^{-12}$ cm.³ sec.$^{-1}$.

(ii) From the duration of radio echoes observed by Millman[1], we may deduce[3] that for a Perseid meteor of visual absolute magnitude $-2{\cdot}0$, $q = 1{\cdot}25 \times 10^{15}$ ion pairs per cm., and for a Geminid of absolute magnitude $-3{\cdot}0$, $q = 1{\cdot}43 \times 10^{14}$ cm.$^{-1}$.

(iii) Millman[1] has given the mean height of Perseids and Geminids of absolute visual magnitude $+0{\cdot}5$ as 102·6 km. and 97·0 km. We may assume that these heights apply to the brighter meteors as well, and compute values of the diffusion coefficient, D, from the results of Greenhow and Neufeld[4].

Substitution of the values of sections (i), (ii) and (iii) and $t = 1{\cdot}0$s. in equation (1) yields the luminosity, I, of a cm. length of meteor train. These values are given in Table 1.

Table 1. Luminosity of Perseid and Geminid Meteor Trains One Second after Formation

	Absolute visual magnitude	I ergs/cm./sec. estimated from recombination	I_s ergs/cm./sec. observed visually
Perseids	$-2{\cdot}0$	1·22	400
Geminids	$-3{\cdot}0$	3·82	400

Naked-eye observers[1] have recorded the visible duration of trains produced by Perseid and Geminid meteors. We may assume that a line source is on the limit of visibility when it is equivalent to a succession of stars of apparent magnitude + 6·0, all spaced at the limit of angular resolution of the human eye, which is 3·5′ or 0·00102 radians. Thus a train on the limit of visibility, making an angle θ with the line of sight, emits I_0 ergs of visible energy per cm. of length according to the relation

$$I_0 = \frac{4\pi R \cdot F_s \sin\theta}{0{\cdot}00102} \qquad (2)$$

where R cm. is the range of the element of the train and F_s is the flux produced by a star of 6th magnitude between wave-lengths of 4680 A. and 5560 A. For an unreddened star of apparent photo-visual magnitude[1] + 6·0 and spectral type *AO V*, the formula of Cook and Millman[5] and the tables of Milford give

$$F_s = 1{\cdot}52 \times 10^{-8} \text{ ergs cm.}^{-2} \text{ sec.}^{-1} \qquad (3)$$

If the observer's field of attention, of approximate diameter 0·4 radian, is centred on the radiant, then the mean value of sin θ for a large number of trains is 0·138.

In the radio-visual correlations described by Millman the mean range R of the trails was 155 km., which we adopt for the trains. From the train observations we may deduce that for − 1·0 magnitude Perseids and − 2·0 magnitude Geminids the trains were at the limit of visibility 1 sec. after the passage of the meteor. The observed luminosity from equation (2) is included in Table 1.

A comparison shows that the meteor train is about two hundred times brighter than we would expect from ionic recombination. We are led, therefore, to postulate an alternative method for storing energy and producing visible radiation. A possible method is the formation of active nitrogen which afterwards excites neutral meteor atoms in the trail[6]. This mechanism is being studied further at the time of writing, and the results will be published elsewhere.

Gerald S. Hawkins
Allan F. Cook

Harvard College Observatory,
Cambridge, Massachusetts.
Feb. 20.

[1] Millman, P. M., *J. Roy. Astro. Soc. Can.*, **44**, 209 (1950).
[2] Öpik, E. J., *Proc. Roy. Soc.*, A, **230**, 463 (1955).
[3] Greenhow, J. S., and Hawkins, G. S., *Nature*, **170**, 355 (1952).
[4] Greenhow, J. S., and Neufeld, E. L., *J. Atmos. Terr. Phys.*, **6**, 100 (1955).
[5] Cook, A. F., and Millman, P. M., *Astrophys. J.*, **121**, 250 (1955).
[6] Whipple, F. L., I.A.U. Publication (in the press).

Effect of Drawing on the Infra-red Dichroism of Nylon-66 Filaments

We wish to report on studies made of the polarized infra-red spectra of variously drawn nylon-66 filaments, where it has been found that the method used for specimen preparation may have an important influence on the experimental results. The optics of the 0·78 N.A. reflecting microscope used, in connexion with a Perkin–Elmer Model 12-*C* infra-red spectrometer, were identical with those mentioned by Quynn and Steele[1]. A set of silver chloride sheets was used for obtaining polarized radiation.

A series of nylon-66 filaments, prepared by melt spinning and ranging in draw ratio from one (undrawn) to four, was kindly supplied by E. I. du Pont de Nemours and Co. The undrawn filaments had a diameter of about 120 microns, which decreased with drawing to about 65 microns at draw ratio four, or at each draw ratio the filaments were approximately twice the diameter of those used by Quynn and Steele[1]. Specimens of approximately 4–6 microns in thickness were found suitable for infra-red examination, and these were prepared by microtoming.

It is possible to obtain desirably thin specimens by mechanical flattening of single filaments as well as by longitudinal sectioning with a microtome. But we have found that the flattening process can induce orientation in a filament and that this effect is accentuated when the filament is of initially low orientation. Such induced orientation may be greatly reduced when longitudinal sections are prepared by microtoming filaments embedded in a plastic. The embedding medium used in our work was plasticized polymethylmethacrylate. Three different methods of specimen preparation were used: (*a*) microtoming of previously flattened samples with the direction of blade motion parallel to the filament axis, (*b*) microtoming undeformed samples in a direction perpendicular to the filament axis, and (*c*) microtoming undeformed samples in a direction parallel to the filament axis.

Another problem associated with microspectroscopic examination of fibres in the infra-red region is that of delusive energy or 'stray light'. When only the nylon filament is located at the specimen stage of the reflecting microscope, it is found that a significant portion of the energy transmitted to the thermocouple of the spectrometer is energy which has gone around the edges of the filament and has become part of the filament image at the entrance slit of the monochrometer. In our experiments the 'stray light' was masked out at the specimen stage by placing pieces of thin aluminium foil, with slits 30–70 microns wide, over the longitudinal sections of filaments.

In calculations of the dichroic ratios shown in Table 1, allowance has been made for the reduction of energy caused by scattering at the sample, but no correction has been made for the effect of beam convergence in the reflecting microscope. It may be shown, using an analysis of the type described by Fraser[2], that the latter effect is a small one. Generally, the mean values shown in Table 1 are for measurements made on 5–14 filaments. In the cases

Table 1. Dichroic Ratio ($\varepsilon\pi/\varepsilon\sigma$) Values for Nylon-66 Filaments

cm.$^{-1}$	Draw ratio			
	1·0	2·0	3·0	4·0
(*a*) Microtoming previously flattened samples in direction parallel to filament axis				
3,310	2·39	0·88	0·79	—
3,080	2·35	0·90	0·78	—
2,925	1·37	0·94	0·90	—
2,860	1·58	0·92	0·89	—
(*b*) Microtoming in direction perpendicular to filament axis				
3,310	1·18	0·81	0·56	0·50
3,080	1·14	0·77	0·61	0·54
2,925	1·03	0·68	0·63	0·56
2,860	1·06	0·81	0·68	0·66
(*c*) Microtoming in direction parallel to filament axis				
3,310	0·78	0·72	0·54	0·55
3,080	0·78	0·67	0·52	0·45
2,925	0·93	0·73	0·70	0·68
2,860	0·85	0·78	0·70	0·65

of part (*a*) of Table 1 at draw ratio three and of parts (*b*) and (*c*) at draw ratio four, however, only two filaments were studied.

When appropriate statistical consideration is given the results, it is observed that the effect of specimen preparation is greatest at draw ratio one and becomes less important at the higher draw ratios. Flattening induces considerable parallel dichroism of all the four absorption bands at draw ratio one, and this effect is much greater than that caused by microtoming plastic-embedded filaments in a direction perpendicular to the filament axis. Some perpendicular dichroism appears to be induced at draw ratio one when the microtoming is done in a direction parallel to the filament axis.

The dichroic behaviour of the 3,310 cm.$^{-1}$ band (N—H stretching) is identical with that of the 3,080 cm.$^{-1}$ band (presumably N—H stretching). The two methylene-group stretching motions at 2,925 and 2,860 cm.$^{-1}$ exhibit nearly the same dichroic behaviour, and the extent of their dichroism is generally less than that of the two N—H stretching motions. With these filaments, there is no reversal of dichroic character in going from draw ratio two to higher draw ratios, as was observed by Quynn and Steele[1]. The results suggest a random arrangement of nylon polymer chains at draw ratio one, with increasing drawing causing increasing alignment of these chains with respect to the filament axis.

The results of X-ray diffraction studies carried out on these filaments are consistent with those of the infra-red measurements. It is suggested that the parallel dichroism found for the four nylon absorption bands at the lower draw ratios by Quynn and Steele[1] was caused by the mechanical flattening procedure they used to obtain suitably thin specimens.

The experiments discussed here will be reported in greater detail elsewhere.

GINO CAROTI
JOSEPH H. DUSENBURY

Textile Research Institute,
Princeton, New Jersey.
Dec. 16.

[1]Quynn, R. C., and Steele, R., *Nature*, **173**, 1240 (1954).
[2]Fraser, R. D. B., *J. Chem. Phys.*, **21**, 1511 (1953).

Biological Research in East Africa

IN the account, entitled "Zoonoses in East Africa", of the conference held earlier this year in Kampala by the East African Medical Research Scientific Advisory Committee (see *Nature*, March 3, p. 406), it is stated (p. 407, col. 1) that "it is regrettable that in East Africa so little collecting is being done". Contrary to this statement, the Coryndon Museum, Nairobi, has hundreds of thousands of specimens and receives two thousand specimens monthly. A few lines further on, the article says, "it is difficult to get birds, mammals or insect identifications done in East Africa". Again, contrary to this statement, the Coryndon Museum, Nairobi, under Dr. L. S. B. Leakey, the curator, can do all this and, more to the point, has type specimens.

For birds, the Coryndon Museum has a first-class ornithologist and the finest collection of East African birds anywhere. We have now the two volumes of "The Birds of Kenya" by Mackworth-Praed and Grant. The Museum has a very fine and extensive collection of insects and a first-class entomologist, while the small mammals are rapidly being built up under the mammologist. The same applies to snakes. The Botany Section is just as good, while the Palæontological and Archæological Sections are known all over the world. Again, the Fish Division of the Kenya Game Department has a very great knowledge covering the past twenty years on these matters and has published a great deal of it. The Jinja Fisheries Research Station has begun publication of "The Fresh Water Fishes of Uganda", and Kenya also has ready the manuscript for a like book on the fresh-water fishes of the Colony. With reference to the marine fishes, this is the work of Prof. J. L. B. Smith, and shortly to appear is a publication covering marine fisheries of Kenya. The Natural History Society of Kenya has published a report on the "Fauna of Tanganyika"; and its volumes are full of such papers. This brief list shows that the information exists, and work is being done.

The need for faunal surveys in the Colonies has been realized for at least the past twenty years; but we have never had the money, and unless this is forthcoming, these surveys cannot be undertaken. We work in co-operation with the British Museum and with their specialists, and rightly so; and get much help from them. However, the crux of the matter is that there is no co-ordination between the various services in East Africa and the scientific workers there. This lack is proved by the article describing the conference. It is one of the most serious problems in East Africa. Scientific officers work in isolated places, cut off from associates both in a Colony and with men working on the parallel problems in other Colonies. There is no free exchange, either oral or written, of work being done or even written reports of work being done, and although heads of scientific and development departments realize this, yet very little has been done to make things easier. I speak from many years experience of Africa.

HUGH COPLEY

Game Department,
P.O. Box 241,
Nairobi.
April 10.

No one would wish to fail to acknowledge the work being done at the Coryndon Museum: the difficulties under which the Museum labours are brought out by Mr. Copley in his final paragraph. Formal surveys of the type asked for have not, in fact, been possible. They were called for at the Kampala conference by East African biologists. It was these same East African biologists who spoke of the difficulties they encounter in getting birds, mammals and insects identified. It is perhaps significant that the more confident note was struck by a visiting American speaker; but he was referring to the British Museum. All concerned in biological and medical work in East Africa would be happy to see the staff of the Coryndon Museum in a position to afford the services so urgently called for. The organization of the conference was itself an effort to overcome the isolation and lack of contact which Mr. Copley mentions.

J. N. P. DAVIES

P.O. Box 2072,
Kampala.

FORTHCOMING EVENTS

Wednesday, July 25

Society for the Promotion of Nature Reserves (in the Lecture Room, British Museum (Natural History), London, S.W.7), at 4 p.m. —Lieut.-Colonel J. Vincent: "Game Reserves of Natal"; also colour film "Zululand Sanctuary".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting—"Visit of the Royal Society Delegation to the U.S.S.R.". Chairman: Prof. A. V. Hill, F.R.S. Speakers: Dr. Mary L. Cartwright, F.R.S., Dr. H. G. Thornton, F.R.S., and Dr. D. C. Martin, F.R.S.E.

Thursday, July 26

Royal Society of Tropical Medicine and Hygiene (at the Hospital for Tropical Diseases, 4 St. Pancras Way, London, N.W.1), at 7.30 p.m.—Clinical Meeting.

Thursday, July 26—Saturday, July 28

Royal Meteorological Society (at the Pantycelyn Hall of Residence of the University College of Wales, Aberystwyth)—Meeting in honour of Sir David Brunt, Sc.D., F.R.S.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Agronomist (with a university degree in agriculture) to assist in field experiments dealing with grassland and arable crops—The Secretary, The Grassland Research Institute, Hurley, Maidenhead, Berks (July 28).

Director (scientist of established reputation under 60, with outstanding research work to his credit, and administrative experience) of the Indian Association for the Cultivation of Science—The Registrar, Indian Association for the Cultivation of Science, Jadavpur, Calcutta 32, India (July 28).

Research Assistants (with good honours degrees) for research in the following fields: heterogeneous catalysis; corrosion reactions; plastics materials; organic synthesis; physics; or electronics—The Registrar, College of Technology, Suffolk Street, Birmingham (July 28).

Physicist (with an honours degree in physics) for work on the clinical applications of radioactive isotopes—The Registrar, The University, Leeds 2 (July 30).

Assistant Lecturer (with special qualifications or interests in radio astronomy) in Physics—The Registrar, The University, Manchester 13 (July 31).

Director (with an intimate knowledge (preferably with actual experience) of tsetse fly control operations, and sound scientific knowledge of the ecology and biology of the tsetse fly, together with proved administrative ability of a high order) of the Department of Tsetse and Trypanosomiasis Control and Reclamation, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Public Service Attaché, Rhodesia House, 429 Strand, London, W.C.2 (July 31).

Demonstrator (with an honours degree in chemistry or biochemistry) in the Department of Chemistry and Biochemistry—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 1).

Assistant (with an honours degree in botany, preferably with postgraduate experience in plant pathology) in the Advisory Plant Pathology Department—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 10).

Lecturers (3) (with a degree or equivalent qualification) in Crop Production; and a Lecturer (with a degree or equivalent qualification) in Animal Production, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (August 16).

Chair of Botany at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Chair of Mineralogy and Geology at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

Lecturer (with an interest and experience in biophysics) in Physiology—The Secretary, The University, Aberdeen (August 31).

Senior Lecturer (graduate from a recognized university school of mines, with the minimum qualification of bachelor's degree in mining engineering or equivalent, wide experience in the practice of mining, and preferably experience in lecturing) in Mining Engineering at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

Reader in Applied Thermodynamics in the University, and Head of the Department of Mechanical Engineering, in Robert Gordon's Technical College—The Secretary, The University, Aberdeen (September 25).

Reader in Pure or Applied Mathematics—The Secretary of Faculties, University Registry, Oxford (October 31).

Experimental and Assistant Experimental Officer (preferably with experience with transient oscillography or vacuum techniques, and at least H.S.C. (science) or equivalent), for interesting work on problems involving high energy electrical discharges through gases over a wide range of pressures—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. B.795/34.

Extraction Metallurgist or Chemist (preferably with a physico-chemical background and some industrial experience), for research and development on treatment of slags—Dr. F. D. Richardson, Nuffield Research Group, Royal School of Mines, London, S.W.7.

Lecturer or Assistant Lecturer in Physical Chemistry—The Registrar, The University, Nottingham.

Lecturer (with research interests in either inorganic or physical chemistry) in Inorganic Chemistry—Northern Polytechnic, Holloway, London, N.7.

Librarian (qualified male librarian with experience of technical libraries)—The Secretary, The Institution of Mining Engineers, 3 Grosvenor Crescent, London, S.W.1.

Medical Laboratory Technician (with either A.I.M.L.T. or B.Sc. in the Research Department—The Group Secretary, c/o General Hospital, Sunderland.

Physicist (male, with a good honours degree or A.Inst.P.), for research on servo-control mechanisms—The Wool Industries Research Association, Torridon, Headingley, Leeds.

Professor of Anthropology and Sociology at the College of Arts and Sciences, Baghdad, Iraq—The Cultural Attaché, Royal Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

Senior Lecturer in Electrical Engineering; a Lecturer in Electrical Engineering; and an Assistant, Grade B, to teach mathematics up to higher National Diploma standard—The Registrar, Hatfield Technical College, Hatfield, Herts.

Senior Lecturer in Physics to teach up to B.Sc. (Special) Degree standard and to share in the postgraduate work of the Department—Northern Polytechnic, Holloway Road, London, N.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Aero Research Technical Notes. Bulletin No. 158: The Place of Metal Bonding in Modern Aircraft Structures. Pp. 4. (Duxford: Aero Research Limited, 1956.)

Heating and Ventilating Research Council. Bulletin No. 1 (April 1956). Pp. 12. (London: Heating and Ventilating Research Council (J. Duncan Ferguson, Acting Secretary, 9 Clarges Street), 1956.)

Scottish Marine Biological Association. Collected Reprints, 1955 (Nos. 185–208). (Millport: Scottish Marine Biological Association, 1955.)

Admiralty Bulletin No. 77: The Hydrographic Department of the Admiralty. Part 3: The Oceanographical Branch. By Commander G. P. D. Hall, R.N. Pp. 5. (London: Admiralty.)

Other Countries

British Territories in Borneo. Annual Report of the Geological Survey Department for 1955. By F. W. Roe. Pp. vii+241+50 plates. (Kuching: Government Printer, 1956.) 3 Malayan dollars; 7s.

El Atomismo de Gassendi: La ley de Inercia, los Albores de la Química y la Teoría Cinética de los Gases. Da Francisco Solano de Aguirre. (Monografica Cosmológicas. Serie Renacimiento.) Pp. 10[illegible]. (Barcelona: José Porter, 1956.)

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology. No. 15: Items 8547–8772 (January to June, 1954). Pp. i+313–336. (Ottawa: Queen's Printer, 1956.) 25 cents.

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien. Band 6, Nr. 3: Studies on Naturally Occurring Ionizing Radiation with special reference to Radiation Doses in Swedish Houses of Various Types. By Bengt Hultqvist. Pp. 125. (Stockholm: Almqvist och Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1956.) 16 kronor.

Institut Royal Météorologique de Belgique. Contributions. No. 2[illegible]. Éléments de Météorologie. Chapitre 6: l'Eau dans l'Atmosphère. Par Dr. L. Dufour. Pp. 32. No. 29: Interpretation of Ionospheric Results during Eclipses. Par Dr. M. Nicolet. Pp. 2. No. 30: La Métrologie par les Interférences. Par Dr. A. Descamps. Pp. 2[illegible]. Publications. Série A, No. 12: Les Hivers à Bruxelles-Uccle (1833–1951). Par Dr. A. Vandenplas. Pp. 46. (Bruxelles: Institut Royal Météorologique de Belgique, 1956.)

Institut Royal des Sciences Naturelles de Belgique. Exploration Hydrobiologique du Lac Tanganika (1946–1947). Résultats Scientifiques. Vol. 3, Fasc. 5 B: Poissons Cichlidae. Par Max Poll. Pp. 620+10 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1956.)

Engineering News: Quarterly Journal of the West Pakistan Engineering Congress. Vol. 1, No. 1 (February 1956). Pp. 64. Annual subscription, Rs. 5; Single issues, Rs. 2. (Lahore: West Pakistan Engineering Congress, 1956.)

Publications of the Allegheny Observatory of the University of Pittsburgh. Vol. 10: Photographic Determinations of the Parallaxes of 823 Stars with the Thaw Refractor. Pp. vii+169. (Pittsburgh: Allegheny Observatory of the University of Pittsburgh, 1956.)

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office